A TREATISE ON THE ATTACK AND DEFENCE OF Fortified Places:

INCLUDING

AN INVESTIGATION OF THE ADVANTAGES WHICH, IN POINT OF STRENGTH, SUPERIOR POLYGONS have over those of an Inferior Order;

AND

An Explanation of the Differences in the Methods of carrying on the Attack, according to the Nature of the POLYGON.

WITH

AN ILLUSTRATION OF THE POWERFUL DEFENCE

Which such Parts of a Fortress as may happen to consist of several Fronts constructe on a straight Line, or on a concave Curve, are capable of making.

Besides various other Matters immediately connected with the principal Subject.

BY

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LONDON:

PRINTED FOR T. EGERTON, BOOKSELLER TO THE ORDNANCE, MILITARY LIBRARY, NEAR WHITEHALL.

1824.

TO

HIS GRACE,

FIELD MARSHAL

THE DUKE OF WELLINGTON,

PRINCE OF WATERLOO,

KNIGHT OF THE MOST NOBLE ORDER OF THE GARTER, &c. &c. &c.

Master General of the Ordnance,

THIS Work is most humbly dedicated by the Author, as a feeble Tribute of his profound Respect and dutiful Attachment; as well as of the Gratitude which he feels, in common with all loyal Frenchmen, for the many and highly important Blessings that Europe in general, but the Author's native Country in particular, have derived from HIS GRACE's splendid and ever-memorable Achievements.

INTRODUCTION.

THE intended object of this Treatise is to elucidate, as concisely as the nature of the subject and perspicuity in the explanation allow it, the Theoretical principles and practical process relating to the Attack and Defence of Fortified Places in general; besides various other matters immediately connected with the principal subject. Subsequently to a short exposition of the defective method of carrying on Sieges which was used before Vauban, and of the manner in which this celebrated Engineer improved it, the mode of attack suitable for any place supposed to be fortified according

to the Modern Bastion-System, the Polygon being of an inferior order, is at first illustrated; and, after explaining the advantages which, in point of defence, Superior Polygons have over the others, a method of attacking Places also fortified conformably to the Modern bastion-System, but supposing the Polygon to be of a Superior order, is given.

The superior properties of such parts of a fortress as may happen to consist of several fronts constructed on a straight line, or on a concave curve, are next investigated in this Treatise, which also contains a comparative view, in respect to strength, of Vauban's 1st System and the Modern bastion-System: The process to be followed in attacking Places fortified according to the former System, and such old fortresses as are destitute of Ravelins and Tenailles: An illustration of the advantages and defects of Vauban's Tower-bastion Systems, and Coëhorn's Systems, as well as the methods of

attacking places fortified after these systems, and the means of improving their defence: Besides an investigation of the defects that the Modern bastion-System still retains, an account of the schemes suggested in order to improve it, and some general remarks respecting the requisite arrangement of any well contrived system of fortification.

That Part of the Treatise which relates to the Defence of Fortified Places, contains a general explanation of the preparatory dispositions to be made in order that they may be capable of sustaining a siege; besides a Description of temporary Bomb-proofs and splinter-proofs, which the French call *Blindages*, and the methods of making them. The construction of Barbet-batteries, temporary Covered - batteries, Retrenchments, Tambours, Traverses, Parados, temporary Powder-magazines, Flêches and Counter-approaches, is also explained in the same Part of the Treatise, as well

as the proper method of palisading the covert-way, and the nature of the operations that the besieged troops are to execute, according to the period of the siege.

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ERRATA.

Page 13, line 23. *For*, that, *read* that is.
36, — 3. *For*, defilated, *read* defiladed.
82, — 6 from bottom, *For*, rather wider and deeper, and its parapet higher, *read*, rather deeper, and its parapet higher.
102, — 3. *For*, their epaulments consisting of the parapet of this trench, and their terrepleins being secured by traverses from, *read* being covered in front by the parapet of this trench, and secured by traverses from
119, — 2 from bottom, *For*, In the mean while sappers, *read*, in the mean while workmen
170, — 15. *For*, (152) *read* (151)
ibid. — 18. *For*, (153) *read* (152)
171, — 3. *For*, (152) *read* (151)
177, — 4. *For*, defiled *read* defiladed.

N. B. The asterisk * in line 1, page 197, should be placed after the words 8 inches thick in the last line of the text in page 196.

ON THE ATTACK AND DEFENCE OF PLACES.

PART I.

ON THE ATTACK OF PLACES.

CHAPTER I.

Object of a siege: General outline of the dispositions usually made by the besieger, and definitions: Method of attacking places which was used before Vauban: Defects of this method: A summary view of the improvements contrived by Vauban, as well as of the advantages that they afford to the besieging troops.

1.—The object of a siege is to take possession by force of a fortified town, the conquest of which political motives, or military views, render important for the besieger. In order to attain this object, he constructs various works designated by the general name of *approaches*,* which, as they

* The name of approaches is at present given in the English service to those trenches which the Author of this Treatise has called *Boyaux*, according to their original appellation, which

consist of trenches secured by a parapet, enable him to advance towards the town under cover of this parapet, and therefore with less danger. He also erects *batteries* composed of different kinds of pieces of ordnance, according to the situations in which they are placed, the period of the siege, and their particular purposes; some of them are intended to subdue the fire of the place, and destroy other means of defence of the garrison, so that the besieger may carry on the approaches still more securely: whilst the other batteries serve him for making breaches, through which he penetrates into the works, after he has advanced to the ditch in front by means of covered communications, called *descents,* which he constructs, and effected those dispositions across it that are named *passages of the ditch.* The object of the dispositions in question is to enable the besieger to cross the ditch with as little danger as possible, for the purpose of gaining the breach, and giving the *assault.*

The approaches, when combined with the batteries, generally take the name of *attacks.*

2.—The art of attacking places was at all times adapted to the nature of the fortifications in use, as well as to the effect of the weapons

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is derived from the French. Particular motives, of no import to the Reader, have led the Author to retain this original appellation.

which were employed to defend them; but, like every other branch of the military art, it has been gradually improved. Immediately before Vauban, places were attacked as follows: One or two fronts were fixed upon, for the purpose of directing the attacks against them, and forts A (Pl. 1. Fig. 1.) were constructed at about 500 or 600 yards from those fronts, in such situations as allowed the besieger to see the works which composed them, to greater advantage. A numerous artillery was then placed in the forts in question, so as to keep up a heavy direct fire against the opposite parts of the fortifications; and *ground was broken** under the protection of the same forts, the approaches being carried on by means of *boyaux a.* (40) so directed as not to be liable to *enfilade* from the place. Upon the right and left of each boyau the besieger constructed trenches *b* called *lodgments, the extent of which* allowed them to contain 30 or 40 soldiers, posted there for the purpose of protecting against sallies the workmen engaged in carrying on the approaches; and these soldiers were supported by as many others as could be stationed in the boyaux without impeding the communication through

* The expressions *to break ground*, or, *to open the trenches*, have both the same meaning, and are used to denote the actual commencement of the attack.

them. After the besieger had gained the salients of the covert-way, and established himself firmly upon the crest of the glacis, he erected batteries *c* in order to *breach* the works through which he intended to force his way into the place; he then executed the descents into the ditches of these works, crossed the ditches, and gave the assault; or else, instead of employing guns to make the breaches, he used mines, which he placed in the escarp of the works to be breached.

3.—Such a method of attacking places undoubtedly was very defective, as, besides other inconveniences arising from it, the batteries situated in the forts A only opposed a direct fire to that of the place, and could not therefore silence it, or even materially impair its effect, but with great difficulty; they feebly protected the approaches, on which account, and because the lodgments *b*, as well as the boyaux *a*, did not afford suitable room for a proper number of troops advantageously posted to repel the sallies, these had the means of attacking the approaches in all directions and destroying a considerable portion of them, before the besieger had time to send such reinforcements as would have been necessary to prevent the sallies from accomplishing this purpose. The besieger was also exposed to the destructive fire that the works of the place concentrated upon the approaches, and

particularly upon their narrow heads; so that, independently of his experiencing a great loss of men, much time and labour was requisite to enable him to arrive at the saliants of the covert-way, which work he always was obliged to *storm;* and when, after several sanguinary conflicts between him and the besieged troops, he had at last succeeded in making and consolidating his lodgments upon the crest of the glacis, he still had to construct the batteries *c*, and execute every other subsequent operation, under the heavy fire that the place generally was still capable of keeping up.

4.—Vauban, having observed the above defects of the process used for attacking places, contrived another method (Fig. 2.) that has the great advantage over the former of rendering the besieger far more secure in carrying on the approaches; for, the *parallels* B C, D E, F G, and the *demi-parallels* H I, K L, M N, which, according to this engineer's method, are to be constructed in situations gradually nearer to the place as the besieger advances towards it, can contain strong bodies of troops who are, in those trenches, advantageously posted to oppose the sallies. The parallels and demi-parallels in question also protect such batteries *d*, *e*, *f*, *g* as the besieger may have occasion to erect within or near them; and therefore, they allow him to

dispose his artillery in a manner more beneficial to his operations. Besides, Vauban's method enables the besieger, as will be shown, to penetrate into the covert-way and other works by means much less dangerous for him than those previously employed; and it also has the advantage of admitting of any modifications that the ground, or the irregularity of the fortifications, may require.

Conformably to Vauban's original arrangement, such as represented by Fig. 2*, the batteries were still direct, so that their effect was improved only by the more advantageous disposition of the artillery in other respects; but, after this eminent engineer had invented the formidable ricochet-firing†, this invention, together with appropriate changes in the situations of the bat-

* At the sieges of Gravelines and Lille, the former in 1658 and the latter in 1667, Vauban departed to a certain degree from the process used by his predecessors; but he only attended completely to his own method, (such as shown by Fig. 2.) at the siege of Maestricht in 1673. This important place was taken 13 days after breaking ground.

† The first use which Vauban made of the ricochet was at the siege of Ath in 1697. The artillery of this place was silenced in a few hours.

Ricochet firing requires that the direction and charges of the pieces of ordnance employed for this purpose should be so regulated that the shot, after just clearing the top of the opposite parapet, will fall upon that extremity of the terreplein to

teries, enabled the besieger to *enfilade* the works, instead of battering them in front; and Vauban's method becoming still more beneficial on that account, as it facilitates the means of placing the ricochet batteries suitably for their intended purpose, it has ever since been followed, with some modifications suggested by engineers who came after him, but which are not very material. This method, improved by the use of ricochet firing, will, as well as the above-said modifications, be applied in the present treatise to the attack, first of a regular hexagon constructed according to the *Modern Bastion System*,* and secondly, of a Dodecagon, also regularly fortified after the same system. In this manner, such readers as may not possess a sufficient degree of information respecting the operations about to be explained, will be enabled not only to acquire a proper knowledge of them, but also to perceive distinctly the differences to be observed in attacking inferior or superior Polygons; besides the advantages which, in point of defence, the latter Polygons have over the former. For greater perspicuity, the

be enfiladed which is nearest to the attacks, and then rise and come down again several times, until by successive bounds it has passed over the whole length of the terreplein.

* For the particulars of the Modern Bastion System, see the Author's treatise on the General Principles of Permanent Fortification, &c. Parag. 159. Page 126.

nature of the operations which the besieger is to execute on each particular day and night of the siege (admitting that no unforeseen events or other motives may render a different arrangement advisable or necessary) will be indicated accordingly, and the whole explanation successively applied to three different periods of the siege. The 1st period will include all the preparatory dispositions of the besieger previous to the opening of the trenches, and the 2nd his operations from the time he breaks ground, to the finishing of the 3rd parallel. To the 3rd period will belong the approaches, &c. carried on beyond the 3rd parallel, until the surrendering of the place,

The superiority of the Modern Bastion System over those anterior to it in which Bastions are used, of course requires that, in attacking a place fortified according to the former system, the besieger should advance with greater precaution; the works which he is to construct being therefore more numerous, and their construction attended with greater difficulty and danger, a longer time is requisite to carry on the attacks. This subject shall hereafter be more particularly elucidated, and the process explained for attacking places fortified according to Vauban's 2nd and 3rd systems, commonly called the Tower—Bastion—Systems, and to the Systems of Coëhorn.

CHAPTER II.

FIRST PERIOD OF THE SIEGE.

Preparatory dispositions requisite before investing a place: Investiture of the place: General plans to be drawn subsequently to the Investiture: Parks and Depôt of the Artillery: Lines of Circumvallation and Countervallation: Encampment of the besieging troops: Park and general Depôt of the Engineers: Directing plan: Methods of determining upon the ground the prolongations of the Faces and Capitals of the Works: Depôts for the Trenches: Last dispositions of the Besieger previous to the opening of the Trenches.

5.—The duration of the resistance which a besieged fortress is capable of making, depends not only upon the actual strength of the fortifications, but likewise upon whether the fortress has a proper garrison, and is equally well supplied in every other respect. It is therefore important that any commander of an army, who is decided to lay siege to a place, should keep his intention secret, and at first execute feigned movements so combined as to allow him to preserve the means of effecting his design as soon as he may

think it advisable, whilst, by deceiving the enemy, or at least rendering him uncertain of the real purpose of those movements, he will perhaps lead him to neglect supplying the place with a sufficient garrison, or such a quantity of artillery, ammunition, provisions, &c. as a defence proportionate to the strength of the fortifications would require. According to circumstances, the feigned movements in question may be so planned as to persuade the enemy that the place intended to be attacked is secure from a siege; or, to excite his apprehensions for several places at the same time, and induce him also to believe that the object of the movements may be an immediate attack upon the defensive army.*

Another precaution materially requisite, before commencing a siege, is to ascertain that the means at hand are sufficient to undertake it;† as, otherwise, the progress of this operation would be re-

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* By the defensive army is meant in this place the army which keeps the field, for the purpose of protecting, in common with the fortresses, the country threatened with an invasion.

† With respect to the requisite number of troops for the siege of a place, it should be estimated not only according to the strength of the garrison, as well as to the nature and extent of the fortifications, but also in consequence of the means that the enemy may have of sending a considerable force to attack the besieger, and oblige him to raise the siege.

tarded, and the ultimate result precarious. The artillery, ammunition; tools, &c. necessary for the besieging army, are to be assembled in depôts cautiously established in such situations behind it as may not enable the enemy to draw inferences from them with respect to the views of the army, and will however render convenient the conveyance to the latter of the various supplies which the depôts contain. The carriages, horses, and other means of conveying these supplies, as soon as they may be wanted, should of course be secured.

6.—Subsequently to these dispositions, and the commander of the besieging army finding a favorable opportunity to commence his operations against the place, he instantly sends a corps towards it, which, when the country round the place is open, should chiefly consist of light cavalry, with some light infantry; but a greater proportion of the latter is necessary in a country intersected by woods, hedges, ravins, &c. This corps is to be accompanied by horse-artillery, and has for its object to form what is called the *investiture* of the place; that is, to occupy suddenly, at the same hour, and if possible without being expected by the troops of the garrison, all the avenues by which they might receive succours, or give notice of their situation; so that these troops being deprived of the means of com-

municating with the country, may be reduced to their own resources. The investiture also enables the engineers to reconnoitre the environs of the place, and the fortifications.

7.—The process used for investing a place shall now be explained.

The investing corps advances as rapidly as possible towards the place, and when arrived at 5 or 6 miles from it, the commanding officer of this corps divides it into several detachments, each of which, by going round the place, repairs to the spot designated for it. At a signal given by means of firing such a number of guns as was agreed upon, all these detachments march forward at the same time towards the place, seizing, as they advance, upon any persons and cattle, &c. that they may happen to meet. They also take possession of the villages, castles, parks, and other advantageous situations.

After halting at such a distance from the place as secures them from its fire, the detachments in question take advantage of the cover which the ground may afford, in order to establish as near the place as can be safely done a line of small posts, so disposed as to be conveniently succoured in case of necessity. The communications of these posts, both with each other and the detachments, are kept up by a double chain of patroles; and, for greater security, sentries and videttes are placed at the points most advantageously situated for dis-

covering whatever may come out of the fortress, or attempt to approach it. If there should happen to be villages, or other important situations, about 1800 yards distance from the place, they are to be occupied, and sometimes intrénched, so as to keep the garrison in check, and prevent it either from seizing upon any of the investing troops, or facilitating the introduction of succours into the fortress, and carrying off such provisions, forage, and other objects, as may be in the neighbourhood. It is to be observed that the detachments just spoken of should face towards the country, and the small posts towards the place.

The above dispositions are those which the investing corps is to make during the day; but night being the most favorable time for introducing succours into the place, and also for coming out of it, the investiture should then be more close. In consequence, the detachments approach towards dusk to the distance of about 1200 yards from the fortress, and establish small posts in their front, as before, all the troops facing likewise in the same manner; that the detachments face outwardly, and the posts inwardly. They observe the greatest silence, and use double vigilance and precaution both against the garrison and any attempts from without Upon the appearance of daylight they retire by degrees to the positions which they had previously occupied, the engineers examining, as well as cir-

cumstances permit, the arrangement of the fortifications, and the ground.* These dispositions are to be repeated every day and night until the arrival of the besieging army, which will generally take place three or four days after the investiture; and this army, whilst advancing, should manœuvre in such a manner as to secure the investing troops from any movements dangerous for them that the garrisons of the collateral places, or some other troops which the enemy may have in the neighbourhood, might otherwise execute.

8.—The place being invested, the engineers avail themselves of the protection of the troops for the purpose of advancing night and day as near the fortifications as possible, and reconnoitring them, as well as the country round them. They carefully observe the form and nature of

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* If by displacing the whole of the investing corps, in order to station it nearer to the place during the night, positions should be abandoned which afford material advantages to this corps for the purpose of preventing the introduction of any succours into the town, the commander should endeavour to regulate his dispositions for the night in such a manner as to continue occupying the positions in question, and yet keep an effectual look-out in respect to the garrison. The proper distribution of the investing corps, under those circumstances, of course depends on the nature of the country, the strength of the garrison, and the number of other troops which the enemy may have in his power to send, in order to impede the investiture.

the ground, and in short endeavour to procure every information which, by enabling them to ascertain on what side the place may be attacked to greater advantage, puts it also in their power to determine the spots where the *parks* of the artillery and engineers ought to be established. The engineers likewise examine whether the quantity of wood in the neighbourhood is sufficient for the great number of fascines, gabions and pickets, &c. that the siege will require*; and, if it should be intended to construct *lines of circumvallation* and *countervallation* (10 and 11,) they extend their observations to the disposition most suitable for each of these lines†. All these details are laid before the commander

* Fascines *a* (*pl.* 3, *fig.* 11) are composed of straight rods and branches tightly pressed and bound together, in a cylindrical form, with withes. Trench-fascines usually are 6 feet long, and 9 in. in diameter. A gabion *b* consists of a kind of cylindrical basket, open at both ends, which is made with rods wattled between pickets, and secured in several places, so as to form what is called *the web* of the gabion. The exterior diameter of a sap-gabion is 1 foot 8 inches, and the height of the web 2 feet 9 inches.

† When it is intended to construct lines of circumvallation and countervallation, the engineers commonly make a plan of the country round the place, to the distance of between 3000 and 3600 yards. This plan is called *The general plan of the environs of the place*, and exhibits an accurate description of the principal parts of the ground, such as the streams, marshes,

of the besieging army, who subsequently makes a reconnoisance himself, and then definitively settles the arrangements to be made*.

The most important roads are likewise to be inspected immediately after investing the place, so as to repair them, if necessary; whilst the distribution of the besieging troops, in the different camps that they are to occupy during the siege, should be regulated and such a number of peasants assembled in the adjacent villages, as may be wanted. They should be kept in sight.

9.—The parks of the artillery should be established on that side of the place where the attack is to be carried on, their situations being concealed, if possible, from the view of the garrison. When

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inundations, woods, steep places, &c. The scale used for it generally is 3-fourths inch, or 1 inch, to 200 yards.

* Several French Authors recommend the use of balloons in reconnoitring fortresses, as, by this means, the nature and form of the fortifications, and the manner in which they defend the ground in front, may with good telescopes be correctly ascertained; as well as the new works that the garrison may have thrown up, the disposition of the artillery of the place, the communications across the ditches, and the situations of the store-houses and other public buildings, &c.

Speaking of the use of balloons, for the purpose of reconnoitring fortified places which it is intended to besiege, Gay de Vernon says in his *Traité élémentaire d'Art militaire, &c*, that the observations may be made at the distance of 1500 metres, (about 1640 yards) from the place.

the country does not afford such situations, the parks are not to be nearer to the fortifications than about 3600 yards, as a shorter distance would render them liable to the fire of large guns. It is also necessary that the roads leading to them should be convenient for carriages, and that an abundant supply of water for horses should be found in the neighbourhood. One of these parks is called the *Grand Park*, and the other the *Little Park*. The pieces of ordnance of every description, which are requisite for the siege, are collected in the grand park, together with the shot, shells, powder, &c. The little park is about 80 yards distant from the former, and contains the forges, the artificers, and their workshops, the carriages for their tools, the combustible preparations, the materials and implements for making them, and various other objects that the service of the artillery requires.

The security of the parks of the artillery is a circumstance of the greatest importance; on which account, those parts of the lines of circumvallation and countervallation that immediately protect them, should particularly be adequate to a suitable defence, besides the parks being secured in flank by means of a small number of field-works detached from one another; or, if it were not intended to construct any lines of circumvallation and countervallation, intrenchments

may be thrown up round the parks, for the purpose of securing them. Troops, consisting of infantry of the line and light cavalry, are likewise to be appointed for their defence, and the villages in front should be occupied by light infantry and cavalry.

10.—By *lines of circumvallation* are meant intrenchments which a besieging army occasionally constructs round the place, at the distance of about 3600 yards from it. They face towards the country, and have for their object to cover the troops encamped behind them, so that they may be secured from any sudden attack which parties of the enemy might otherwise make upon some of them, in order to force their way into the place. By shutting up every passage leading to the town, the lines in question also prevent the enemy from availing himself of the obscurity of the night, for the purpose of corresponding with the besieged troops, or sending supplies to them; and they likewise are sometimes intended to enable the besieger to resist with advantage any attempt of an army to raise the siege.

Lines of circumvallation have of late been little used, as the custom generally prevailed of covering the operations of the siege with an *army of observation*, so posted as to watch the enemy's movements, and succour the besieging troops, or receive assistance from them, according to cir-

cumstances. It must be admitted, however, that an army of observation does not render these lines entirely useless, although they may be less necessary; the reason is, that the enemy may deceive the army by his manœuvres, and thus succeed in succouring the place. Besides, if the army should happen to be attacked, and defeated, it may retire behind the lines, so as to recover from the check which it has sustained, and allow the siege to be continued under its protection. This of course supposes that sufficient means of communicating with the country will remain to the army, to enable it to receive any supplies that may be requisite for it.

If it be now supposed that any army, which undertakes to besiege a place, is not sufficiently strong to form a proper corps of observation, besides affording the necessary number of troops for carrying on the operations of the siege, lines of circumvallation will in this case be of the greatest utility, if not actually indispensable;* for, parties may at first be kept in advance of

* It is evidently supposed in this place, that, although the army may not be sufficiently numerous to admit of forming two separate corps, yet its strength, and the protection afforded by the lines, allow it to oppose an effectual resistance to such forces as the enemy may be capable of sending against it. Under different circumstances, it would be much better not to undertake the siege.

these lines, in order to procure information respecting the enemy; and as soon as they have ascertained that he is assembling his troops, a kind of vanguard, consisting of a strong detachment, may be sent for the purpose of observing and harassing him; advantageous fields of battle, between him and the besieging army, may also be reconnoitred, and defensive dispositions made in such situations as will admit of them. Upon being informed of the enemy's approach, as well as of the nature of his movements, the commander of the army will have it in his power to take any measures which circumstances may lead him to think advisable; either, by forming the whole army in order of battle behind the lines, with the exception of that portion of it which is necessary to secure the trenches from the garrison; or, by advancing towards the enemy, with the troops not employed in guarding the trenches, &c. in order to surprise him in his march, and attack him. The siege may likewise be temporarily raised, and the artillery sent to some neighbouring places, together with the other important objects belonging to the army, so that all the troops may be brought against the enemy, and such a victory obtained as will allow the siege to be immediately recommenced.

It is certainly to be acknowledged that lines of circumvallation have two material defects;

first, on account of their circular form, the enemy sees their interior in flank and in reverse, immediately after he has penetrated through any part of them. Secondly, as in case of their being attacked, the action will take place at a short distance from the trenches, it is to be greatly apprehended that the army which defends them will not be able, if defeated, to retreat in such good order as would allow the artillery, &c. used for the siege, to be safely removed, and therefore secured from falling into the hands of the enemy. Consequently, engineers, employed in constructing lines of this description, should contrive all possible means of making them adequate to a strong resistance, and particularly endeavour to render a considerable portion of their circumference inaccessible to the enemy. For this purpose, the engineers are to avail themselves of the steep places, courses of water, and other natural obstacles that the ground affords: to render the marshes impassable and the woods impenetrable: to form inundations: and to establish fixed batteries in the situations most advantageous for them, &c. Those parts of the lines which the enemy can attack being thus in small number, each of them may be defended by a much greater force than if the whole lines should require to be guarded; and, for the same reason, they admit of

being fortified in a manner more effectual; especially if, besides having their extremities terminated at the inaccessible parts, which parts should be so disposed as to flank them, the ground allows the different fronts which they form to be placed on concave curves, or on straight lines flanked from distance to distance by strong works, having a proper projection beyond them.

11.—Similarly to the lines of circumvallation, those of *countervallation* consist of intrenchments, but face towards the place, being about 2400 yards distant from it. Their object is to secure the camps of the besieging troops from the enterprises of the garrison, as well as to protect and thus facilitate the operations relating to the opening of the trenches; they are particularly useful when the garrison, being numerous, is therefore capable of acting to some distance from the fortifications.

Instead of establishing the countervallation in a continued line, it will very frequently be sufficient to fortify only some particular spots advantageously situated; attending principally to the security of the parks of the artillery and engineers, as well as to that of the most exposed camps. Those villages and other situations advanced towards the place, where it is important

that troops should bivouac, are likewise to be protected by works.*

12.—It was said that the besieging army is distributed in several camps round the place. The object of this disposition is to guard all the passages through which the garrison might receive succour; and likewise, to have troops at hand for the purpose of defending every part of the lines, either of circumvallation or countervallation, which the enemy might have in his power to attack. Each camp is to be established at the distance of 200 yards, or thereabouts, behind the former lines; and in whatever camp the nature of the ground may allow cavalry to be placed, a sufficient number of troops of infantry should also

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* Troops, assisted by a considerable portion of the peasants collected in the villages at the time of the investiture, are employed to construct the lines of circumvallation and countervallation, under the direction of engineers and sappers: whilst other troops, also accompanied by peasants and experienced sappers, repair to the woods in order to cut down trees, and prepare the palisades, chevaux de frise, barriers, &c. requisite for the lines, where these objects are subsequently conveyed.

Parties of soldiers and peasants are likewise sent to the woods with experienced sappers, who direct them in making gabions, fascines, pickets, and sap-fagots; according to circumstances, either the cavalry carries these objects on horseback, or they are conveyed in waggons to the places assigned for them.

be posted there, to flank this cavalry and defend such a portion of the parapet of the lines as covers the camp, or is contiguous to it.

The great importance of having safe and convenient communications from one camp to another, as well as from the parks of the artillery to the camps, must appear evident if it be considered that, under different circumstances, no reliance could be placed upon the speedy arrival of troops, artillery, and ammunition, at such quarters as might want to be immediately re-inforced in case of an attack. Therefore, whenever two camps are separated by a stream or a river, a sufficient number of bridges, about 100 yards distant from each other, should be made across it,* and covered by palisaded redans, having redoubts inside of them. If, instead of a stream or a river, either an inundation or a morass should intervene between the camps, dykes made of fascines, and of such elevation as will exceed the level of the highest water, are to be constructed. The communications through the steep parts of the ground should be rendered easy by means of cutting ramps which form gentle declivities. The hedges are also to be cut down, and the ditches filled up, &c. In short, every means of facilitating the communications should be used.

* These bridges may according to circumstances stand upon trestles, or be made by means of pontoons, or of boats.

13.—After determining on what side the fortress shall be attacked, it still remains to choose the front against which the attack is to be directed,* and the besieging army is usually provided with a more or less correct plan of the place, which may supply useful information in respect to this very important choice; yet, it would be imprudent to rely entirely upon the plan in question, for fear of errors or omissions; and therefore it ought to be verified, so that a new one may be made, if necessary, from the results of the fresh operations.† For this purpose, the engin-

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* Whatever number of troops any besieging army may be reasonably supposed to contain, and however great its means in every other respect may also be, yet this army will not have it in its power to attack the whole of the works round the periphery of the place. Besides, this process would be unnecessary, as it is sufficient to direct the operations against one, or occasionally two fronts. It is even to be observed that, in case of two attacks being carried on, one of them generally has a secondary object to answer; such as fatiguing the besieged troops, obliging them to divide their artillery, &c. and facilitating the progress of the principal attack.

In choosing the *front of attack*, the weakest front from the nature of the fortifications is not invariably fixed upon, as a stronger one is sometimes preferred either on account of the ground before it being more favorable for carrying on the approaches, or because the situation of this front will allow the besieging army to receive its supplies with greater convenience.

† This plan is called the *General Plan relating to the*

eers make a survey of the fortifications, including the environs of the place, to the distance of 1500 yards; and, in order that the garrison may not suspect the real point of attack, they proceed as if they were carrying on the survey round the whole fortress.

The engineers particularly endeavour to determine with precision the principal angles of the works, and especially the saliant angles, those of the covert-way not excepted; for, by this means, they have it in their power to ascertain exactly the situations of all the works the fire of which can bear upon the attacks; and accurate information in this respect is far more important than any precise knowledge of the particular figures or respective proportions of these works. If it should happen that the saliants of the covert-way cannot be distinctly made out, the utmost is to be allowed for its breath, as well as for that of the ditch behind; and both the covert-way and ditch are to be laid down upon the plan, with the supposed dimensions.

Besides making the plan just mentioned, the engineers write down fresh observations upon every important circumstance which they can discover, with respect to the fortifications and the

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choice of the front of attack. The scale usually is two inches, or thereabouts, for 100 yards.

ground; such as the apparent strength of the fronts that they have reconnoitred, and the advantages or inconveniences which the nature of the soil, or the face of the country, presents for carrying on the approaches, &c. Useful particulars, which the engineers may not be able to ascertain by their own observations, will sometimes be obtained by means of questioning the inhabitants of the country, as well as the deserters and the prisoners.

14.—The front of attack being fixed upon, the engineers immediately establish their park facing it, at the distance of 1500 yards from the place. Spades, shovels, pickaxes, pickets, cordage, &c. are collected in this park, together with the surveying instruments and other objects of this description which may be wanted during the siege; and a considerable supply of fascines, gabions, sand-bags, &c. is also deposited there, or in the neighbourhood. The engineers likewise form a *general-depôt* opposite the centre of the front of attack, this depôt containing, like the park, spades, shovels, pickaxes, sand-bags, fascines, gabions, pickets, &c. Its proper distance from the place is about 1200 yards, and both the park and general depôt should as much as possible be placed in situations which secure them from the fire of the garrison.

A depôt for the artillery is also formed near the general depôt of the engineers.

15.—Whilst the above arrangements are carrying on, the engineers also set to work in order to make a *particular* plan called the *directing plan,* as it subsequently serves to direct the operations of the siege; and they include in this plan not only the front intended to be attacked, but likewise all the collateral works the situations of which allow their fire to bear upon the attacks; they carefully describe too the particulars of the ground, and afterwards repair to it for the purpose of ascertaining and marking upon it the prolongations of the faces and capitals of the works. These operations are performed as follows :

16.—Before repairing to the ground, in order to determine and mark the prolongations of the faces, the engineers trace them indefinitely in the directing plan, so as to know nearly the different points on the ground, through which they pass; and being come to such of these points where the operation is proposed to be carried on, they proceed to verify them; for this purpose, each engineer first places himself in the direction of the magistral line of the face the prolongation of which he is ordered to take, or, if that line cannot be distinctly seen, he makes use of the interior crest of the parapet. Whichever of

these two directions the engineer may prefer, he marks it by two pickets *a*, *b*, (Pl. 2. Fig. 6.) at the distance of about 40 or 50 yards from each other.

The above operation requires much precision, and if the prolongations determined upon the ground do not agree with those on the directing plan, the latter must be rèctified.

17.—In respect to the prolongations of the capitals, the engineers also trace them on the directing plan, before they repair to the ground; and when they are arrived at any suitable points where, according to this plan, the prolongations in question should pass, they place themselves in a line with the saliant angles of the works and those of the opposite covert-way; after which, they mark by two pickets *c*, *d*, the prolongations thus determined, and rectify them on the directing plan, if it be requisite. This simple process affords a sufficient accuracy when carefully employed, and it therefore renders trigonometrical operations useless; especially, as the capitals do not indispensably require so much precision as the faces, in determining their prolongations, since a small deviation from their true direction is of no material consequence. The most favourable time for distinguishing a saliant is when one of the faces which form it is enlightened, and the

other in the shade; the time of sun rising or setting is particularly advantageous.

After marking upon the ground the prolongations of the faces and capitals of the works, the distances of the pickets used for this purpose from the saliants of the covert way are to be measured, and transferred to the directing plan, so that the situations of the pickets may be accurately represented in this plan.*

18.—Depôts containing objects of the same nature as those collected in the other depôts (14) are to be formed in the directions of the capitals of the front of attack and contiguous ravelins; being placed in situations A 800 or 900 yards distant from the fortress, and which should as much as possible be covered from its fire. The proximity of these depôts to the trenches affords the means of expeditiously and conveniently conveying to the latter the various supplies requisite to carry on the operations of the siege; on which account they are called the *depôts of the trenches*.

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* If an engineer, having to measure the distance from any part of the prolongation of a capital to the opposite saliant of the covert-way, should happen not to see this saliant distinctly, he must take the distance to the work immediately behind, and deduct from it the breadth of the ditch as well as the length of that portion of the prolongation of the capital which crosses the saliant place of arms. The directing plan will give these two dimensions.

19.—Indeed, it is scarcely possible to fix, with any degree of precision, the necessary length of time to complete the preparatory dispositions which a besieging army is to make before opening the trenches. Particular circumstances may undoubtedly occasion differences in this respect, but experience has shown that from eight to ten days, or thereabouts, will in general be requisite.

20.—As it is very important to conceal from the knowledge of the garrison the spot where it is proposed to break ground, since otherwise this operation would be attended with much greater danger to the besieger, feigned reconnoissances should be made at several other places round the fortress, for some days before the trenches are to be opened. A certain quantity of fascines, &c. may also be collected in those places, and troops marched about in their vicinity; or, a show of communications may be made, which are not intended. In short, every means should be used for the purpose of deceiving the garrison.

21.—This last observation will be made respecting the preliminary dispositions of the besieger, before he opens the trenches; namely, whenever the besieger intends to form several attacks, he should if possible make such arrangements as will allow him to break ground at all of them in the same night, so as to divide the attention of the garrison on the next morning; and,

if he has not sufficient means to do this, he ought to begin with the attack which, from its object, or the smaller extent of the labour that it requires, is the least important; so that the attention of the garrison being directed to this attack, the trenches may be subsequently opened at the principal one, with less difficulty and danger.

CHAPTER III.

SECOND PERIOD.

Opening of the trenches: Description and requisite length of the 1st parallel, as well as its usual distance from the most advanced saliants of the covert-way, the direction most suitable for it, and the manner in which its extremities should be secured: Profile adapted to the 1st parallel, and proper disposition of the troops who are to cover the workmen employed in constructing this parallel: Process generally used for tracing the first parallel on the ground, and carrying on the excavation: Manœuvres of the covering party, if attacked by a sally, for the purpose of repelling it: Arrangement, &c. of the 1st batteries: Tracing and constructing of the boyaux and great communications: 2nd parallel: Flying-sap: Regular single-sap: demi-parallels: 3rd parallel: Changes in the besieger's dispositions against sallies, according to the na-

ture of his works beyond the first parallel, and their distance from the place.

22.—THE opening of the trenches consists in digging the trench B C *(pl. 2. fig. 6.)* called *the 1st Parallel,* and constructing the parapet which covers it. This parallel forms straight branches connecting points previously determined and marked in the prolongations of the capitals of the works belonging to the front of attack, as well as in those of the capitals of the ravelins contiguous to it; its length should allow it to embrace the prolongations of the faces of all the works in question, so that a strong body of troops being posted in it may protect against sallies the batteries E, and the workmen engaged in constructing the boyaux D and *the great communications* M*. The latter answer the double purpose of serving as passages from the 1st parallel to the 2nd, and covering in flank the trenches between these two parallels.

23—The 1st parallel is in general established so far as 600 yards, or thereabouts, from the

* Such troops as are posted in the besieger's trenches, for the purpose of defending them and the workmen against sallies, are called *the guards of the trenches.*

most advanced saliants of the covert-way, as, at this distance, the fire of the artillery of the place is of course less certain than if the distance should be smaller. The noise occasioned by the excavating of the ground also is less likely to be heard by the garrison, and there is a greater danger for sallies of their retreat being cut off. However, should any natural cover enable the besieger safely to break ground nearer than 600 yards to the above said saliants, he ought to avail himself of this advantage, as he will thereby save time and labour.*

24.—Although it is not requisite that parallels should be precisely at the same distance from the place for their whole length, yet no portion of them ought to be much further off. They must pass through those parts of the country from whence the ground in front is best seen and can be defended in the most effectual manner,

* The absolute necessity of accelerating the taking of the place may also lead the besieger to break ground at a smaller distance from it than 600 yards; or else, he may do so in consequence of his being certain that the place is not properly supplied with artillery and troops. Under such circumstances, and particularly when the fortifications are weak by their nature, the besieger may likewise dispense with several dispositions that a stronger place, well provided, would indispensably require.

whilst the troops in the parallels will be least exposed to a plunging fire from the place. Defilated situations are particularly advantageous.

To protect the extremities of parallels, *Returns i* defiladed from the place, and 30 or 40 yards long, may be made *; or else, if the garrison should be numerous, redoubts may be constructed instead of returns, and particularly at the ends of the 2nd parallel. Such sides of these redoubts as face the place being more exposed to the fire of large guns than the others, require a stronger profile; and, in order that neither sides may be liable to enfilade, the redoubts are usually made pentagonal, or in the form of a lozenge. (*See the redoubts* I.)

25.—The parapet of the 1st parallel generally has no revetment†; and in *fig.* 4, *pl.* 1*st*, which

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* The profiles of the returns *i* are regulated according to the same principles as those of parallels.

† Several distinguished Authors, who have treated of the art of attacking and defending fortified places, recommend that the parapet of the 1st parallel should be reveted with fascines, as represented in *fig.* 3; so that the parapet being strengthened, the security of the troops whom it covers may be still greater. But whether the parapet be reveted or not, these troops will in most cases be sufficiently secured after the parallel has been brought to its proper dimensions; and therefore, such an additional security as they might acquire from a revetment being

represents a section of this parallel, the parapet *a* is made 4 ft 3 in. high under the supposition that the fire of the besieged place is moderately plunging. But if the parallel, or any part of it, should be exposed to a very plunging fire, the parapet must be raised higher in that part than abovesaid; whereas, on the contrary, its height may be diminished in defiladed ground. The interior slope *b* of the parapet stands at an angle of about 45° with the natural ground; so that troops can conveniently pass over the parapet for the purpose either of marching out of the parallel, in order to attack such a sally as may happen to advance towards it, or returning to the banquette, if they had been repelled, and from thence keeping off the sally by their fire. The berm *c*, 18 or 20 in. wide, forms the banquette*, and is supported by a slope which,

made, would not be an advantage capable of compensating for the material inconvenience occasioned by the increase of labour and the considerable number of fascines that the forming of the revetment would require.

* It was suggested that banquettes 3 feet wide (*fig.* 3) would, in parallels, be preferable to those which only have the usual width of 18 or 20 inches, as the latter do not admit of troops being posted upon them in more than one rank; whereas the former affording room for two ranks, the troops who occupy

as it is cut out of the natural ground, has a base not exceeding 1 foot in breadth; this base may, in good soil, be made still narrower. In order to enable the troops in the parallel to mount upon the banquette with convenience, and to

them could keep up a more powerful fire against sallies, than the other troops. But it is to be observed that, by increasing the width of the banquette, the reverse of the parallel would be further distant from the parapet, and therefore less effectually covered by it from a plunging direct fire. (*See the next note*). Other inconveniences would also arise from the breadth of the banquette being augmented, and after all, the intended object of this augmentation would not be attained; for, soldiers drawn up in two ranks on a banquette 3 feet wide, behind a parapet close to them, must evidently impede each other to such a degree as not to be able to fire over the parapet with that convenience which would be necessary in order that they might take proper aim and their fire be effectual; and, if for the purpose of allowing them a larger space, the banquette should be made wider than 3 feet, the reverse of the parallel would be still more distant from the parapet; so that the cover which it receives from it would be proportionally diminished. It is consequently much better (unless the parallel is placed on defiladed ground) that the breadth of the banquette should not exceed 18 or 20 in. as abovesaid; but if it should be wished that a brisk and yet efficient fire should be kept up from it, the guns used by the men in one rank who occupy it, may be loaded and handed to them by other men standing either upon the step *d* (*fig* 4) or at the bottom of it. In this manner, the men on the banquette will be enabled to fire much quicker, and no impediment will prevent them from taking proper aim.

descend from it, the height of the front of the trench is equally divided by a step *d* 1 foot 6 in. wide; and, as this step and the slope supporting it, are both formed with earth brought from the rear or *reverse,* so much as 1 foot 6 in. is allowed for the breadth of the base of the slope. The trench is 7 feet 6 in. broad at bottom, and 3 feet deep in the front; but it is made deeper in the reverse, so that any man who stands in this part of the trench may have as much cover from the parapet as if he were standing in the front part*; besides, this disposition facilitates the means of draining off the rain water, so as to keep the trench dry. Lastly, the reverse of the trench is formed, like the front, with a step *e* 1 foot 6 in. wide; but this step being cut out of the natural ground, as well as its slope and that which supports the natural ground above it, not more than 1 foot is allowed for the width of each of these two slopes at the base. This

* Supposing the besieged fortress to command the parallel, and the ground where the latter is placed not to be defiladed, any direct shot, either grazing the top of the parapet of the parallel, or penetrating through it, will evidently pass at a smaller height over the reverse of the trench, than above the front. Consequently, if the reverse should not be made deeper than the front, a man standing in the former would be more exposed than any other man who stands in the latter, since he would have less cover.

dimension may even be *occasionally* *reduced**.

It is to be observed that either the front or the reverse of parallels is not always to be made with steps, but may, according to circumstances, form a continued slope similar to the slope *e* represented in *fig*. 3.

26.—Experience has shown that no soldier of a common size, who stands behind a parapet more elevated above the banquette than about 4 feet 6 inches, can conveniently take proper aim, when firing over the parapet, if for that purpose the muzzle of his gun should require to be depressed as much as ordinary circumstances may render it necessary. Therefore, supposing the height of the parapet of any parallel to exceed the abovesaid dimension, it will be requisite to form a banquette higher than the natural ground, so that in case of a sally presenting itself, this banquette may enable the

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* More than one step may sometimes be requisite in the front or the reverse of a parallel: for instance, when the fire of the place being very plunging, it becomes necessary to make the trench much deeper than usual: or else, when the parallel is constructed on ground sloping downwards in the direction of the place, so that the top of the reverse is much more elevated above the bottom of the trench than it should be in other ground.

besieging troops posted upon it to keep up an efficient fire against the sally. Admitting that the parapet is not reveted, the arrangement of the banquette may simply consist in cutting a step *a* (*fig*. 5) of a proper height and width in the interior slope; but reveted parapets require different means, and a method suitable for parapets of this kind will be hereafter suggested. It will only be said in this place that the elevation of the crest of the parapet above the banquette may in some instances be so small as 4 feet, and should never exceed 4 feet 6 inches; wherefore, these two dimensions may be considered as the extremes of the elevation in question.

27.—The process generally used in order to trace the 1st parallel B C on the ground (*pl*. 2, *fig*. 6) is such as follows:—The commanding engineer having reconnoitred the ground where it is intended to open the trenches, so as to ascertain the direction which the parallel ought to have, he at first describes it in the directing plan, and elucidates, by means of the parallel thus represented, the preliminary instructions which he gives to the other engineers ordered for duty, respecting that portion of the parallel which each of them has to trace. Subsequently to this preparatory explanation, the engineers repair to the ground, at the close of the day: being accompanied by a few attendants, and directing themselves

towards the pickets *c*, *d*, which have previously served to mark out the prolongations of the capitals (17). They plant pickets *n* at the intersections of the parallel with these prolongations; and also to the right and left of these pickets, at such intervals as they think proper in order to insure correctness in the direction of the tracing. White lines or tapes, connecting all the pickets, are then stretched, which represent the interior base line of the parapet. The commanding engineer of course superintends the whole operation.

Whilst the engineers are engaged in tracing the parallel, the working parties appointed to construct it should be assembled as secretly as possible in the depôts A of the trenches, and supplied with the necessary tools; these being taken from the general depôt of the engineers. The workmen are divided into detachments, also called brigades, and their requisite number is generally estimated at the rate of one man for each 5 feet of the length of the parallel; but if it should be wished to accelerate the work, the task of each man may be reduced to four feet.

Several officers of great experience, and highly distinguished by their professional abilities, have expressed their opinion that working parties should have their guns, instead of being unarmed; as in consequence of the confidence

which this would give to the workmen, they would not disperse on the approach of sallies, as they frequently do when without arms. Besides, covering parties less numerous might be employed to protect them against sallies, and this duty would not therefore fall so heavy upon the besieging army; whilst the casualties among the covering troops would probably be diminished from the number of these troops being smaller. It is also to be observed that as soon as the approaches have been pushed on to the distance of musket shot from the place, it becomes absolutely necessary to station part of the guards of the trenches in the boyaux, as they would be eminently exposed in front of them; and, independently of other inconveniences, the communication through the boyaux is so much the more impeded by troops being stationed in them, as these troops are in greater number. However, the apprehension of incumbering the workmen, and especially when besides their tools and guns they would also have materials to carry, has hitherto prevented the general adoption of the method of arming them; and this method only was attended to, in some instances*. It was

* Speaking of the Flying Sap (48) such as executed in the sieges undertaken by the Allies in Spain, in the years 1811 and 1812, Lieut. Col. John T. Jones, of the corps of Royal Engi-

perhaps apprehended likewise, that, if the workmen should be vigorously attacked by a strong sally, and driven back beyond the spot where they are at work, they might leave their tools and only carry away their guns; in which case the sally would not fail seizing upon the tools.

The covering party ordered to support the workmen employed for breaking ground, should be assembled in the depots of the trenches, similarly to the workmen. It consists of infantry and cavalry, the latter generally exceeding the cavalry of the garrison, and the former being three-fourths or at least two-thirds of their infantry; but these proportions may undoubtedly be modified, according to circumstances.

Before the covering troops are marched from the depots of the trenches to the ground which they are to occupy in order to protect the workmen, the commander of these troops, accompanied by his principal officers, should recon-

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neers, says in page 328 of his highly-important and valuable publication respecting these sieges, that, in marching to the work, every sixth man carried the arms of the other five, and he afterwards supplied the place of those put hors de travail. The French have translated the abovesaid publication into their own language.

In his report of the opening of the trenches before Pampeluna, in 1823, Marshal de Lauriston also said that ground was broken at the distance of 200 toises (about 427 yards) from the place, *the workmen carrying their arms.*

noitre it; having also with him an engineer who, by explaining the direction that the parallel is to have, enables him to fix upon the spot where each separate division of the covering party is to be stationed; as well as upon the roads that the different divisions are to follow for the purpose either of gaining their respective posts, or succouring one another in case of necessity.

28.—When it has become sufficiently dark for the covering party to advance without being seen by the garrison, each of the divisions which compose it should repair with the greatest silence to the spot assigned to it; the infantry F being posted in front of those parts of the ground through which the 1st parallel is to pass, and the cavalry G upon the flanks of this parallel. The infantry F, when arrived, are to push forwards detachments *f*, forming echelons, with order not to fire, unless assured that the enemy is advancing in force, but to charge with the bayonet such of his patroles as may present themselves. These detachments should take post on the most favourable spots for observation, and place sentries in their front for greater security. It is proper that after making their arrangements, all the troops F, and the detachments *f*, should lie down.

29.—As soon as the covering party is posted the workmen should follow, each of them carrying a

spade and a pick-axe. Various methods of marching up the workmen, and distributing them along the white lines, have been suggested, and some of them actually used; nevertheless, the author of this treatise will venture to propose the following process, which may be occasionally modified if the nature of the ground, or any other particular circumstances, should require it.

Let *a b (pl. 2. fig. 7.)* represent the prolongation of any of the capitals either of the front of attack, or of the collateral ravelins, and *c* the picket planted at the intersection of this capital with such a portion of the 1st parallel as 12 detachments, 6 on each side of the prolongation, have to execute. Let it also be supposed that *c d, d e, e f,* &c. indicate the white lines belonging to the 6 detachments on the right. These detachments should march in two divisions from the depot A of the trenches towards the picket *c*, each division consisting of 3 detachments formed rank entire, which, for greater perspicuity in the explanation, are numbered in the figure. When arrived at the picket *c*, the detachment No. 4 turns to the right, and advances in this new direction, with Nos. 5 and 6 behind it, until its leading man comes close to the picket at the extremity *f* of the white line *e f* belonging to it. The detachment then halts, fronts, and the work-

men extend themselves along the white line, the non-commissioned officers taking care that each man takes his proper distance from the next. The leading man of No. 5 being arrived at *e*, this detachment also halts, fronts, &c. and so does No. 6, as soon as its leading man is at *d*. In the mean while, the detachments Nos. 1, 2, 3, of the other division file off behind the former, so as to gain their respective white lines *h i*, *g h*, *f g*; and, after gaining them, they halt and front, &c. similarly to the detachments Nos. 4, 5, and 6.

This very simple manœuvre is to be executed at the same time, but in a contrary direction, by the detachments on the left of the prolongation *a b* of the capital, these detachments of course forming two divisions, like those on the right, and each division being also drawn up rank entire. Therefore if the parties of workmen assembled in the 5 depots of the trenches are all marched up and distributed along the white lines in a similar manner, the parties which proceed in contrary directions, between each two capitals, will meet, and the whole operation be conveniently and speedily performed.

In order to remove every apprehension of the confusion which might arise from the leading detachment of any division happening to mistake its own white line, a non-commissioned officer

should be stationed there previous to the arrival of the division.

30.—With respect to the excavating of the parallel, it is to be carried on as follows:—Supposing *fig.* 4, *pl.* 1st, to represent the profile of the parallel, and therefore 2 feet 8 in. to be allowed for the breadth of the berm *c* and the base of its slope, the workmen should commence the excavation at this distance in the rear of the white line; observing to cut the ground perpendicularly to the depth of 3 feet, and to throw the earth to the front of the white line. The excavation being continued until the trench is 10 feet 6 in. wide, the steps and slopes are then to be formed (25).

31.—Independently of the process which, as previously explained (27.) is generally used in order to trace out the 1st parallel, white lines only being employed for this purpose, there is another method according to which the workmen lay close to these lines fascines brought by them from the depots of the trenches; after which, the white lines are removed, and laid in a direction parallel to the fascines, at a distance behind them equal to the breadth of the berm and the base of its slope, so as to fix the place where the excavation is to be commenced. This method may have the advantage of preventing any mistake which, by the other method, the workmen might make

respecting the space to be left for the berm and its slope; but even admitting that they might not precisely observe the dimension requisite for that space, yet they cannot materially deviate from it if the overseers carefully attend to this point, as they ought to do. Besides, supposing fascines to be used for the tracing, the workmen would have to carry them, together with their tools; so that, if it were thought advisable that they should also carry their guns, they would be much more incumbered by them than without the fascines.

The particulars relating to the tracing and constructing of boyaux will be hereafter explained; therefore it is only necessary to observe in this place that the 3 sets of boyaux H in the rear of the 1st parallel, (*pl.* 2. *fig.* 6) should if possible be traced and commenced at the same time as the parallel itself; although it may strictly speaking be sufficient to begin at that time the 2 sets in the directions of the prolonged capitals of the bastions.

31.—If in order to interrupt the workmen employed in constructing the 1st parallel, any sally should approach it in front, it is to be opposed at first by the infantry who cover the workmen, so that the latter may continue their work under the protection of the former; and if the infantry should be obliged to fall back, they must

retire into the parallel (which the workmen, if unarmed, are then to quit*) and there make a stand until reinforcements being arrived, they march forwards and briskly attack the sally in front and in flank. In the mean while, the cavalry should advance upon the flanks of the sallying troops, as well as in their rear, and endeavour to cut them off from the place.

32.—At day-break, as many as possible of the infantry who covered the workmen during the night, should retire into such portions of the parallel as are in a sufficient state of forwardness to receive them; the others are to lie down on the reverse, and the cavalry to take post under any cover near the flanks, which the ground may afford. If there should be no cover, epaulments *k* 8 feet high (*pl.* 2. *fig.* 6) ought to be constructed at the same time as the parallel, for the purpose of securing the cavalry behind them. All these troops are relieved in the morning by others, who place themselves in a similar manner; observing that the infantry who lie upon the reverse should

* Great care should be taken that the workmen do not disperse after quitting the parallel; and, in order to prevent it, each detachment should be marched in a body to a proper distance in the rear of the parallel, so as to wait there until the sally having retired, the work is resumed.

enter the parallel in proportion as any part of it is ready for their reception.

33.—The workmen of the day also relieve in the morning those of the night*, so as to continue the work which the latter have begun, and it is probable that the parallel will be completed in the course of the next night; in order to cover the workmen employed during that night, part of the infantry who guard the trenches is to take post in front of them, being disposed like in the preceding night (28.); the other part may remain in the parallel.

34.—At the close of the day which follows the opening of the trenches, the engineers trace the 1*st batteries* E *(pl. 2. fig. 6.)* also called *enfilading* or *ricochet batteries,* so that their construction may be immediately commenced. These batteries having for their object to enfilade the faces of all those works of the place the position and distance of which allow them to keep up an effectual fire against the besieger's works, their parapets should be laid out perpendicular to the prolongations of the faces in question. It is consequently proper that, before tracing the batte-

* Cormontaigne recommends that the working party first employed in constructing the 1st parallel, should not be relieved until they have made the trench 3 feet deep and 4 feet wide.

ries, each prolongation should be marked by day-light with two pickets, and such particular spots reconnoitred as are the most suitable for the batteries*.

35.—By placing the enfilading or ricochet batteries in the 1st parallel, their construction would require a shorter time than in any other situation, and the workmen who construct them be less exposed; however, in order to avoid the inconvenience of these batteries impeding the service in the parallel, and render their fire more certain by erecting them nearer to the place, it is customary to establish them 30 or 40 yards in front of the parallel, or even further; and to connect them with it bv means of two communi-

* If it should happen that any impediment, arising either from the nature of the ground or from the disposition of the works of the place, does not allow the besieger to erect a ricochet battery on the spot where, strictly speaking, it ought to be placed, he may perhaps have it in his power to construct it on another spot rather nearer to the place; or else, he may prefer delaying the construction of this battery until the 2nd parallel being made, he will establish it under its protection. It may likewise sometimes happen that the besieger being not able to enfilade one or the other face of a work, he is obliged to erect a direct battery against it; in this case, the battery should be placed on such a spot as will allow the work to be seen to the greatest advantage, and the fire of the battery to be kept up for the longest time, without interfering with the approaches.

cations *l*, about 10 feet wide. If through particular circumstances, the beseger should occasionally be induced to place any of the abovesaid batteries in the parallel, those parts of it which they separate must be joined by a communication in their rear.

36.—The arrangement of the enfilading batteries may in general be such as follows:—Three guns may be placed in that part of the battery which crosses the prolongation of the terreplein of the face to be enfiladed, the last of them, towards the centre of the battery, standing nearly in the direction of the interior crest of the parapet of that face, so that the shot may pass close to the interior slope*. These guns serve to enfilade the terreplein, and on their right or left, according to the direction of the face, two mortars may be established, opposite the ditch; whilst the other part of the battery, namely, that which is met by the prolongation of the covert-way, may be occupied by two guns, or rather two howitzers, the nearest of them to the end of the parapet of the battery on that side being so placed as to allow the shot to graze the interior slope of the glacis. With re-

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* By examining any of the enfilading batteries E, it will be seen that its direction allows it not only to enfilade one of the two faces of the bastion or ravelin, against which it is erected, but also to be used as a direct battery against the other face.

spect to the requisite length of the parapet of the battery, supposing an ordinary battery, 18 feet per gun or howitzer are usually allowed, and 15 feet per mortar; besides the space to be added to these dimensions, for each of the traverses commonly constructed between every two or three pieces of ordnance. For a splinter-proof traverse, this space is generally equal to half the breadth of the traverse at the base.

37.—The besieger's principal object, in constructing the batteries E immediately after breaking ground, is to subdue the fire of the artillery of the place as soon as possible, so that he may advance with greater security; but these batteries also destroy the palisades and barriers of the covert-way, besides annoying the working parties engaged in constructing those traverses, retrenchments and coupures, &c. which the garrison usually commence, without any delay, after ascertaining which front the besieger intends to attack. It should likewise be remarked that when the besieger being arrived within musquet shot from the place, the besieged troops posted on the terrepleins begin to make use of their musquetry fire, this fire, which in general is not then checked by that of any other batteries but the batteries E, would of course prove more prejudical to the besieger, if the abovesaid troops should not be exposed to the effect of these batteries.

38.—Thirty-six or forty hours are generally requisite to complete the batteries just spoken of*; so that being commenced in the 2nd night, they will be able to open their fire on the 3rd day. They should begin firing by daylight, in order that the proper charges may be ascertained, as well as the angles of elevation and the directions suitable for the different pieces of ordnance which the batteries contain. These directions are commonly marked upon the hurters and platforms, for the purpose of enabling the artillery-men to attend to them in the night. It is to be observed that all the batteries should be ready before any one commences playing, as otherwise, a very powerful fire from the fortress would be drawn upon them separately, so as to destroy them one after another in a short time.

Whilst the besieger is engaged in constructing the 1st batteries, he should also commence, in

* It is supposed in this place that the besieger erects *elevated batteries*, so that the parapet is raised for its whole height above the natural surface of the ground ; but the construction of these batteries requires a much longer time than that of *sunken*, or *half-sunken*, batteries. A battery is said to be sunken, when the terreplein is placed some feet below the natural ground; in such a manner that this ground forms the *sole*, or bottom, of the embrasures; whilst a half-sunken battery derives its name from the terre-plein being sunken to a smaller depth than that of a sunken battery.

the 2nd night, the great communications M, and, if possible, the 3 sets of boyaux D leading from the 1st to the 2nd parallel; or at least the 2 sets which cross the prolongations of the capitals of the bastions.

39.—The sallies becoming more frequent, and more dangerous for the besieger, in proportion as he advances beyond the 1st parallel, the workmen who construct the boyaux D and great communications M should be covered in the night by a proper number of troops posted in their front, and upon their flanks; particularly when they are arrived near the spot where the 2nd parallel is to be established. All these troops are to lie down, and, in case of any sally presenting itself, they should unite in order to oppose it, so as to give time to the infantry and cavalry stationed behind them to come up to their assistance. The covering party is to retire at day break into the parallel and such portions of the boyaux and great communications as are completed.

The workmen employed in constructing the batteries E should also be covered by troops posted in their front, and upon their flanks.

40.—A boyau consists, like a parallel, of a trench which is covered by a parapet; but supposing the boyau and the parallel to be constructed at an equal distance from the place, on the same kind of ground, the former will generally

require a higher parapet than the latter, and a deeper trench, in order that men standing in it may be equally secured. Besides, no fire is usually kept up over the parapet of boyaux, these being merely used as communications*; and therefore, a regular banquette is requisite in such bo-

* The boyaux serve as communications for the troops and light carts, but the guns and mortars of the batteries usually are conveyed to them across the fields, during the night; as besides incumbering the boyaux, they would from their great weight cut them up at bottom to such a degree, and particularly in rainy weather, that the passage through them would become very inconvenient, if not impracticable. Ramps are made in the reverse of the 1st parallel, just opposite the entrance into the communications *l* (*pl.* 2, *fig.* 6) leading from this parallel to the batteries E, so that the guns and mortars of these batteries may pass through the ramps and communications in question. With respect to the artillery of the batteries erected beyond the 2nd and 3rd parallels, passages are made for it either by throwing bridges of timber across such trenches as they may have to traverse, and cutting openings through the parapet immediately in front of these bridges, or by some other means variously contrived.

Bousmard justly observes that besides the abovesaid inconveniences which would arise from the guns and mortars being conveyed to the batteries through the trenches, instead of across the fields, no advantage would be gained, in point of security, by using the former method in preference to the latter; for, the fire of the garrison being constantly directed against the besieger's works, the passage through the clear intervals between them must on this account be less dangerous.

yaux only as may occasionally havé to contain troops for the purpose either óf flanking the reverse of a parallel, at one or the other extremity of the latter, or defending by their fire a particular spot where the besieged troops might establish themselves, and from thence annoy the besieger. In any other boyau, a berm about 1 foot wide is sufficient; and with respect to the interior arrangement of the trench, it is, excepting the depth, much the same as in parallels. The profile of the great communications M is similar to that of the 1st parallel. (*See pl.* 1*st, fig.* 4.)

41.—Boyaux are for various reasons usually placed upon the prolongations of the capitals of the works towards which the besieger advances. First, as these prolongations give the shortest distance from any of the parallels to the next, less time and labour is requisite to construct the boyaux. Secondly, the boyaux are generally more secure in this situation than in any other, because the musquetry fire of the works of the besieged place cannot defend their own capitals, unless the saliants are very obtuse; and, even in this case, the fire must be very oblique, which renders it of little effect*; whilst only one gun, in each saliant, can

* In order not to uncover themselves, soldiers posted behind a parapet generally fire over it straight forwards, without endeavouring to take proper aim, so that the shot follows a direction

be fired precisely in the direction of the capital prolonged; and, if to the right or left of this gun, others should be placed along the faces, for the purpose of firing them in a direction parallel to the prolongation of the capital, suitable embrasures for these guns could scarcely be made, in consequence of the considerable degree of obliquity that the lines of fire would require. Lastly, by placing the boyaux as abovesaid, their parapet incommodes the batteries in their rear as little as can be done.

42.—In order that the boyaux may not be seen into by the besieged troops, and enfiladed by their artillery placed in the saliants, as might happen if the boyaux were laid out in right lines parallel to the prolongations of the capitals, they obliquely cross these prolongations, to the right and left alternately; thus forming angles with them, the opening of which is augmented in proportion as the boyaux are nearer to the fortress, so that such a direction may be given to the former as will allow their prolongations to clear all the works of the latter, and therefore secure the boyaux from being enfiladed by any of these works. None of the boyaux between the parallels

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perpendicular to the crest of the parapet, or nearly so. This accounts for the little effect of the musquetry fire whenever it should be kept up in an oblique direction.

should be extended farther than from 40 to 50 yards beyond their intersections with the prolongations of the capitals, those which are the furthest from the place being generally made the longest; and, similarly to the boyau *o q*, *(pl 2, fig. 6.)* every boyau ought to be prolonged 5 or 6 yards beyond its junction with the one immediately behind it, so as to form a return *o p* which not only protects against oblique shot the head of the boyau in the rear of the other, but affords a sort of recess where one of two parties meeting in opposite directions may retire, until the other has passed. Each return is to be terminated by a slope of 4 or 5 feet, as a passage will thus be formed which may occasionally prove very useful for entering into the boyau, or getting out of it. It is to be observed that the communications made beyond the 3rd parallel are not laid out in the form of zig zags, like the boyaux, as this form would evidently not allow them to be defiladed from the works situated on their flanks. This subject will be hereafter treated of.

43.—Boyaux directed according to the usual method just explained, form acute angles *a b c*, *d e f* (*pl.* 2, *fig.* 9.) with the parallels; and it has been suggested, as an improvement of this method, that small returns *g*, *h* (*fig.* 10.) might be made, having a direction parallel to the prolongations of the capitals. The reason assigned in

favour of this suggestion is that the angles *a b c*, *d e f* (*fig.* 9.) being acute, there is no sufficient room, at least near the vertices of these angles, to construct a parapet of a proper solidity. But it seems that inconveniences must arise from the short turnings which the returns *g* and *h* occasion; as well as from the frequent necessity of making the return *g* much wider than the boyau leading to it, so that earth may be procured for the purpose of erecting, on each side of this return, a parapet which may protect it against oblique shot. Such are probably the motives which have hitherto prevented the returns in question from being commonly made. Indeed, supposing the besieged fortress to be erected on a polygon of a superior order, and its works upon the right and left of the boyaux to have a great projection, the besieger may be obliged to secure himself from the fire of these works by a parapet on each side, before the time when such a disposition is usually requisite; but this is a different case, which will be hereafter investigated.

44.—Before tracing any boyaux on the ground, they are usually described in the directing plan (15); and, supposing *pl.* 2, *fig.* 6, to represent that plan, whilst the boyau *m o* is to be laid out on the ground, the engineer appointed for this operation takes note of the length which, accord-

ing to the directing plan, the boyau in question is to have; as well as of the distance from its intersection *r* with the prolongation of the capital, to the point *n* where this prolongation meets the 1st parallel. He also specifies in his note the distance *m n*, which fixes that part of the parallel from whence the boyau is to be pushed out; and, in the dusk of the evening, he repairs to the spot for the purpose of determining by measurement, under the protection of troops lying down in front, the situations of such points on the ground as correspond to those *m*, *r*, *o*, in the directing plan. In proportion as the engineer determines the situations of the former points, he plants pickets there, which are subsequently connected by white lines. The other boyaux *o q*, &c. may evidently be traced out by a similar process.

The following method might also be used in order to trace the boyau *m o* on the ground, or any of the other boyaux. According to this method two lines are employed, one of which is equal in length to the distance *m r*, measured upon the directing plan, and the other to the distance *n r*; the former line being fixed at one end to the picket *m*, and the latter to the picket *n*, a man at the other end of each line stretches it, and walks towards his companion until those extremities of the lines meet, which the two men respectively hold. It then only remains to lay a line in the prolong-

ation of the line *m r*, so as to complete the length that the boyau is to have.

Whether the engineer employs one or the other of the two methods of tracing boyaux on the ground which were just explained, greater security requires that he should endeavour, by looking close to the horizon, to see the saliants from which the boyaux are to be defiladed; so as to ascertain that the prolongations of the latter will pass at a suitable distance in front of the former(42); whilst before commencing the operation, he should in the course of the day observe some remarkable objects situated in the proper directions of the boyaux, and which being nearer to them than the saliants, may be better seen at dusk. This means alone may even be occasionally sufficient.

The working parties who construct the boyaux in the rear of the 1st parallel, or between this parallel and the 2nd, are marched up rank entire, and the workmen distributed at the same distance apart behind the white lines, as those employed for the 1st parallel (27); they of course face towards the parapet, and form the trench in the manner explained (30) respecting this parallel.

45.—Unless the besieged troops have made strong and successful sallies, or the besieger has been obliged to delay the construction of several of his ricochet batteries, he will probably be able

to gain the spot for the 2nd parallel in the course of the 5th night, and therefore, to commence this parallel in the beginning of the following night. It is usually placed at about half the distance from the 1st parallel to the most advanced saliants of the covert-way, but rather nearer to the parallel than to the saliants, so that the ground between the 1st and the 2nd parallels may be more effectually defended by the musquetry fire of the former. The workmen, and particularly those employed at the extremities of the parallel, are covered by detachments, chiefly consisting of grenadiers, who take post at 50 paces in their front, or thereabouts; being also supported by other troops stationed, some of them in the 1st parallel, and the remainder in the boyaux between it and the 2nd parallel. The troops in front of the workmen should lie down in the night, and retire at day-break into such portions of the 2nd parallel as are ready to receive them.

If after his arrival during the night on the ground where the 2nd parallel is to be established, the besieger should have sufficient time to construct *amorces* before day-light, that is, short portions of this parallel extending to the right and left of each of the boyaux next to it, he ought to avail himself of this advantage; as troops posted in these amorces will prove very useful, in the event of the garrison making a sally before the parallel is completed.

46.—The 2nd parallel is usually made rather wider than the 1st; and its length should in general be such as to allow the latter to overflank it, at each end, so that *it may* protect its flanks against any sally advancing upon them.* Besides, the shot from the batteries erected at the ends of the first parallel, in order to enfilade the faces of the ravelins collateral to the front of attack, will not have to pass over the parapet of the second parallel, which advantage may sometimes be very material. However, if the besieger had been obliged, as may occasionally happen, to postpone the construction of the batteries in question, so as to place them at the extremities of the 2nd parallel; or, if having constructed them, it should subsequently be necessary to remove them to these extremities, then the 2nd parallel ought of course to be longer than abovesaid, since under the supposed circumstances, it must embrace the prolongations of those faces of the ravelins collateral to the front of attack, which the batteries are intended to enfilade.

Likewise, with proper precautions, the besieger generally succeeds in concealing from the knowledge of the garrison the spot where he intends to break ground, as well as the time of his breaking it; consequently, this operation is seldom attended with any great danger to him, and, at all events, he is exposed to no musquetry fire from the works of the place, their distance considerably exceeding the range of

* The 2nd parallel should likewise outflank the 3rd, at each extremity, so as to protect its flanks against sallies.

a common musquet, and even of a rampart-fusil*; But the besieger constructs the 2nd parallel under circumstances much less favourable to him; for, the nature of the ground, the progress of the attack, and the usual distance of the 2nd parallel from the 1st, enable the besieged troops to judge, with almost a certainty, not only of the spot where the besieger will establish that parallel, but also of the time when he will commence it. Besides, these troops will throw light-balls in the night, so as to see the besieger at work, and he therefore has scarcely any chance of proceeding in his operation without being soon perceived; whilst the advantageous use that the garrison can then make of their musquetry fire, indispensably requires that the besieger's workmen should be secured from it as quickly as possible. In consequence, a particular process, called *The Flying-sap*, is employed for constructing the 2nd parallel†; according to which process the workmen place a row of gabions in their front, before they commence to dig the trench. They speedily fill these gabions with earth, and are then secured from the fire of common musquets.

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* A rampart-fusil consists of a kind of musquet of much larger dimensions than a common musquet, and which has a greater range; the balls used for it weigh each 1 1-3rd ounce, and it is laid on a trestle when firing it.

† The flying-sap is not employed for the 2nd parallel only, but also, at least occasionally, for other works beyond it, as will hereafter be explained. Some of the besieger's lodgments are usually made by means of this sap.

47.— Before giving any detailed account of the ordinary method of executing the Flying-sap, the manner of marching up the working party for the second parallel will be explained: As the distance between every two capitals produced is much shorter in this parallel than in the 1st, and the working party proportionally smaller, the workmen may be marched in two divisions only through each set of boyaux D* and each great communication M, both divisions being divided into brigades, as usual, and formed rank entire, When arrived on the spot where the parallel is to be established, one of the divisions is to turn to the right, and the other to the left; so as to advance in opposite directions until the leading brigade of each division, and the other brigades behind it, meet the whitelines stretched along such portions of the parallel as they respectively have to perform.

48.—With respect to the usual method of executing the Flying-sap:—The working party consists of as many men as there are gabions requisite in order that being placed in front of the white lines, close to them and to each other, they may form a

* If the besieger had commenced the boyaux D, opposite the ravelin of the front of attack, later than those in front of the bastions (38), the former may not be completed at the time when he is to construct the 2nd parallel; and, in this case, the two divisions of workmen marched up in the direction of the prolongation of the capital of the ravelin, will have to pass uncovered over part of the distance from the 1st parallel to the 2nd; but, as it is in the night, and the distance to be passed over without cover will probably be small, the workmen will not be much more exposed than if the boyaux had been finished.

row of the same length as the trench to be made. Of every two workmen, one carries a gabion and a pick-axe, and the other a gabion and a shovel.

The workmen having extended themselves behind the white lines, place their gabions in front of them, as aforesaid; after which, the men who have the shovels lie down at a small distance in the rear of the gabions, whilst each of those supplied with pick-axes breaks the ground behind his own gabion and that of his companion who has the shovel; observing to leave the space for the berm and the slope which supports it, and to cut the ground perpendicularly. After he has broken a certain quantity of ground, he lies down in his turn, and the man with the shovel rises in order to throw into the gabions the earth which the other man has loosened. The sap is carried on in this manner, that is, the men with the pick-axes and those with the shovels alternately working and lying down, until the trench being sufficiently wide to admit of the whole party, they enter it and continue the work. The trench being completed to its proper dimensions, the steps and slopes, &c. are formed*. This method of executing the Flying-sap was originally suggested by Bousmard in his *Essai général de Fortification, &c.*

49.—It is customary to revet interiorly with gabi-

* If in any particular part of the Flying-sap the fire of the garrison should be found very destructive to the workmen, it would be better to remove them, as that part may subsequently be connected with the others, by means of the single-sap (53). This however should not be done without powerful reasons.

ons not only the parapet of the 2nd parallel, but also those of the besieger's trenches beyond it; and the requisite arrangements, in order that the guards of the trenches may conveniently fire and pass over parapets thus reveted, whatever their height may be, are different from those which unreveted parapets admit of, for the same purposes. — For, according to remarks previously made, a parapet of the latter description which does not exceed 4 feet 6 inches in height, allows the original berm to be used as a banquette; and, as the parapet entirely consists of loose earth, the ascent which the interior slope forms is sufficiently easy to enable the guards of the trenches to gain the top of the parapet with a tolerable degree of convenience; whilst, if the height of the unreveted parapet should be more than 4 feet 6 inches, a simple step cut in the interior slope, and occasionally supported by fascines, will allow the soldiers placed upon this step to fire over the parapet, on the top of which the interior slope also enables them to mount. But even supposing that a parapet reveted with gabions is not higher than 4 feet 6 inches, in which case the original berm may serve as a banquette, yet it will be necessary to make steps behind the gabions, in several places along the berm, so that the guards of the trenches may, by means of these steps, mount upon the gabions and from thence upon the parapet, without breaking their ranks; and, if the parapet should be sensibly higher than 4 feet 6 inches, it will be requisite, the berm being too low to form the banquette, not only to construct steps for the pur-

pose of enabling the guards of the trenches conveniently to pass over the parapet, but also to raise the berm. It is proper too, under both suppositions, that the steps forming the passages for the troops should be so arranged as to allow a fire to be kept up over the parapet, from the places where they are made; as without it, the ground opposite these steps would only be defended by the oblique fire of the parapet on each side; so that, independently of other inconveniences, a sally would be able, and particularly in the night, to advance with greater security by marching in the direction of the steps. It is of course to be understood that the soldiers, whilst firing, ought to be properly covered by the parapet.

The two following methods of arranging the steps of a parapet reveted with gabions, as well as the banquette in the intervals between these steps, when it does not consist of the original berm, will be suggested. They are founded on the principles laid down in the preceding paragraph, and either one or the other method may be used, according to the height of the parapet; observing that in the event of this height being not precisely the same as will be supposed for the sake of explanation, the dimensions recommended for the elevation of the banquette, and consequently of the steps, may be modified. Conformably to rule, the arrangement of the banquette and steps must be such as will allow the soldiers conveniently to mount upon the

gabions; whilst the parapet which covers them, when in the act of firing, will not be less than 4 feet in height, nor more than 4 feet 6 inches.

First, supposing the height of the reveted parapet to be 5 feet 3 in., or even only 5 ft. like in *pl.* 2, *fig.* 8, the original berm will in both suppositions be too much below the crest of the parapet, to be used as a banquette. Consequently, a banquette *b* about 9 inches high, and as wide as the berm, may be made upon it for the whole length of the parapet; being supported, as well as the front of the trench, by the continued slope *c*, the base of which is equal to its perpendicular height, or rather more.* This banquette will not only allow the guards of the trenches to fire over the parapet, but will give stability to the gabions, by supporting them; whilst in order to enable the soldiers conveniently to mount upon the tops of the gabions, a step consisting of one course of fascines may be made on the banquette, in each of the places where it is intended to form passages for the troops. But, as by occupying a great portion of the width of the banquette, these fascines would render it unfit for use, if they were fixed, they should be laid loose, so that whenever the soldiers have to fire over the parapet, they may throw them down into the trench, and

* Instead of the continued slope *c* two steps *d* may be made, as shewn by the figure; but they will occupy a larger space in the trench, than the continued slope.

afterwards replace them in their former situation upon the banquette *b**. This may be done with great ease and expedition, as trench-fascines are short and light. It is proper that one course of fascines *a* should also be placed on the tops of the gabions, so as to retain the earth of that part of the parapet which is above them, and enable the soldiers to pass over it with still greater facility, by placing their foot upon the fascines.

Secondly, if the height of the parapet should only be 4 feet 6 inches, so that the original berm may be used as a banquette, steps for the passage of the troops, over the parapet, will only be required. In order to make them, the berm may be raised 6 in. in those places where the steps are to be formed; and, by considering the berm thus raised as being the banquette *b* in the first example, the remainder of the arrangement may be just the same as was explained in that example†.

Although the steps, such as made in the 2nd Example, are 3 inches lower than those in the 1st, yet they will allow the guards of the trenches to mount

* In order that the fascines laid on the banquette *b* may not move from their position, when the soldiers mount upon them, this banquette should be made rather higher in the rear than in the front, so as to have a small inclination towards the gabions.

† It is scarcely necessary to observe that since the original berm, between each two sets of steps, does not require to be raised, the front of the trench, along this part of the berm, may be formed with one step, like in *pl.* 1, *fig.* 4.

upon the gabions with sufficient convenience to avoid breaking their ranks; whilst, in firing, they will be covered by a mass of parapet of 4 feet in height.

50.—The arrangements just suggested, for the purpose of enabling the guards of the trenches to fire and pass over a parapet reveted with gabions, scarcely admit of its height being smaller than 4 feet 6 inches; for, if it were, and the steps should be made sufficiently high to allow the soldiers to mount upon the gabions with convenience, the parapet in front would not cover them properly when firing over it; and, if the steps should be made lower than abovesaid, so that the soldiers may have a proper cover, they could not mount upon the gabions without a sort of confusion. But a besieged place needs not to have any great command to require that the parapet of the 2nd parallel, and particularly those of the besieger's works still nearer to the place, should be 4 feet 6 inches high; whilst the fire of the garrison is seldom so plunging in respect to the besieger's trenches, as to render it necessary that any of the parapets which cover them should be made higher than 5 feet 3 inches, or 5 feet 6 inches at most*; especially such parapets as are afterwards heightened by crenels formed on their tops,

* A parapet 5 feet 6 inches high would of course require the banquette *b* (*pl.* 2, *fig.* 8) to be raised 1 foot above the original berm.

as will be hereafter explained. At all events, admitting that this might happen, it would be much better if instead of raising the parapet beyond 5 feet 6 inches, the trench should be deepened; the additional quantity of earth thus procured being employed in thickening the top of the parapet.

51.—Another method of forming steps, so as to enable troops to fire and pass over reveted parapets of trenches, (*pl.* 4, *fig.* 22 *and* 23), has hitherto been used, and consists in carrying up the steps *c* from the bottom of the trench to the top of the parapet, in the manner shown by *fig* 23. But independently of the great labour which the construction of steps thus made requires, they occupy a considerable part of the breadth of the trench, so that it is necessary to widen it behind them. Besides, the great distance at which the soldiers stand from the crest of the parapet, when firing over it, materially impairs the cover which the parapet ought to give them; and this inconvenience is rendered still greater by the nearness of the trenches where steps of this description are usually formed, to the fortress. Indeed, if after making the trench, the gabions *a* should be removed, and the steps above the berm *b* cut in the interior slope of the parapet, the front of the trench being formed with a step *d*, according to the ordinary method, the labour would be rather diminished, whilst the inconvenience that the steps *c* have of occupying a large portion of the width of the trench, would also be avoided; but

still, the soldiers when firing would not be better covered by the parapet*.

52.—The redoubts I (*pl.* 2, *fig.* 6), at the extremities of the 2nd parallel ought to be traced and commenced in the same night as the parallel itself, the workmen who excavate the ditch being covered by gabions which they place in their front, in the manner of the flying-sap; and, five or six light guns should be placed in each of these redoubts, so as to fire grape-shot upon any sally which might approach the flanks of the parallel.

53. — The workmen who on the 6th day relieve in the morning those of the night, bring the fascines requisite for the parallel, and continue the work.

54.—Such batteries as the besieger may have occasion to erect under the protection of the 2nd parallel, are to be commenced on the 7th night. They should generally be placed either in the parallel, or (what is still preferable) at a small distance beyond it; and, whilst the besieger is making them, he should also complete every unfinished part of the great communications M; as well as the redoubts I, so that they may be supplied with their artillery at the same time as the batteries. These last will probably be ready to fire on the 8th day.

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* By the method of forming steps represented in *pl.* 2, *fig.* 8, the soldiers stand close to the gabions, when firing over the parapet; so that being much nearer to its crest than if any of the methods mentioned in the above paragraph should be used, they of course are more effectually covered.

55.—The boyaux N pushed out from the 2nd parallel should likewise be commenced on the 7th night, generally by means of the single-sap. This sap admits of going on night and day, and may, in very favourable soil, with expert sappers, proceed at the rate of from 16 to 18 feet per hour; but in order to accelerate the construction of the boyaux, advantage should be taken of every opportunity which may occur of using the flying-sap without any great danger; for instance, when the enemy's fire is slackened at intervals, during the night.

56.—A brigade of 8 sappers, forming 2 squads of 4 men each, is employed for the single-sap, and 1 non-commissioned officer is attached to each squad. But as only 4 sappers carry on the sap at one time, the 2 squads alternately relieve each other, and the men of the squad not actually at work pass to those of the other the materials necessary for the sap, such as gabions, fascines, and sand bags, or occasionally sap fagots. The 4 sappers at the head of the sap are supplied each with 1 sap pick-axe, 1 sap shovel, and 1 3 foot rod. One sap roller and 2 sap forks are also requisite.

57. — Sand-bags *d* (*pl.* 3, *fig.* 11) are made of canvas; and, before using them, they are filled with sand or with earth freed from stone. Those employed in saps serve to fill the interstices between each two of the gabions at the head, their length being usually about 20 in. and their width 10 in.

58.—Sap fagots *c* (*pl.* 3, *fig.* 11,) consist of fas-

cines made of stout pickets, which are sometimes used in saps for the same purpose as sand bags; but sand bags are much preferable. The length of a sap fagot is about 3 feet, and its diameter from 9 inches at least to 1 foot, depending on the hardness of the wood of which the pickets are cut; it is traversed in the middle by a picket, pointed at one end, which serves to fix it in an upright position between the gabions.

59.—The sap roller is used for the purpose of covering in front the head of the sap; and the sappers move it into any requisite direction, by means of the sap forks. It consists of a gabion 6 feet long, and commonly 2 feet 8 in. diameter, but sometimes less, which is placed within another of the same length, and 4 feet in diameter. These two gabions are concentric, and the space between them is filled with stout pickets of hard wood. The sap roller was substituted in the British service for the stuffed gabion still used in other services, consisting of a gabion 6 feet long and 4 feet in diameter, which is filled usually with fascines.

60.—Vauban's method of executing the single sap is, with some modifications, still employed in foreign services, where this sap is carried on as follows:— The 1st sapper being covered in front by a stuffed gabion *e* (*pl. 3, fig.* 12 and 13), places a sap gabion *g* close to it, in the exact direction of the sap, and throws into this gabion the earth from a trench 18 inches wide, and as many inches deep,

which he digs; observing to leave the requisite space for the berm *i*, between this trench and the gabion. He then enters the trench upon his knees, and moves the stuffed gabion further on, in order to make room for a 2nd sap gabion *k*, which he places close to the 1st; after which, he fills with two sand bags laid over each other, or with a sap fagot *l*, the interstice between these gabions*, and prolongs his trench, throwing the earth into the 2nd gabion, so as to place a 3rd and subsequently a 4th gabion, &c. in the manner above explained respecting the 1st and 2nd.

The 2nd sapper follows the 1st at the distance of about 5 feet, and augments by 6 inches both the width and depth of the trench that the other has made. The gabions being completely filled, and partly backed with earth, he lays two courses of fascines *m* on their tops.

The 3rd sapper sets to work 5 feet distant from the 2nd, and increases by 6 inches the width and depth of the trench of the latter. His duty likewise is to place one course of fascines *o* over the two courses *m* previously laid on the tops of the gabions.

Last comes the 4th sapper, who commences his work at the distance of 5 feet from the 3rd, and makes the trench 3 feet wide and deep (*fig.* 16), by

* As soon as the parapet is sufficiently thick to be musket proof, the sand bags or sap fagots which fill the interstices between the gabions may be removed, so as to use them in a more advanced part of the sap.

adding 6 inches to the width and depth of the excavation made by the 3rd sapper. The sap is continued in the same manner for its required length; and, as the sappers advance, that part of the trench which they do not occupy is brought to its proper dimensions by a party of workmen usually consisting of one man for each two gabions.

It is to be observed that the same squad of sappers is only employed for 2 hours, during which time each sapper is to be by turn at the head of the sap, and afterwards at the tail. After 2 hours, the squad is relieved by another.

61.—According to the method of carrying on the single-sap which is used in the British service, (*pl.* 6, *fig.* 28), the trench made by the 1st sapper has the same dimensions as in the foreign method just explained; but the 2nd sapper augments the width of this trench by 20 inches, without increasing its depth. The 3rd sapper cuts 18 inches deeper that portion of the trench which the 2nd sapper has dug, thus making it 3 feet deep; whilst the 4th sapper adds 10 inches to the breadth of the trench, or more if he can, and gives a depth of 3 feet to his own excavation. The gabions only have one course of fascines laid on their tops, or occasionally two courses.

62.—Whatever may be the process employed for executing the single-sap, the 1st sapper should throw the earth from his trench carefully into the gabions, and never work behind the empty gabion; whilst after finishing to fill the gabions, the 2nd

sapper ought to throw the remainder of his earth as close to the outside of them as he can. Lastly, the sappers should, in the progress of the sap, endeavour to preserve their distance of 5 feet from one another.

63.—The nearness of the covert-way to the boyaux N in front of the 2nd parallel (*pl.* 2, *fig.* 6), indispensably requires that, in constructing them, the troops who protect the workmen should be posted under cover; on which account they occupy this parallel and such of the boyaux in question as are ready to receive them. But beyond a certain distance from the 2nd parallel, the troops stationed there might be too far off in the rear of the workmen, to come up in time for securing them and their work, in the event of the garrison making a sally. In consequence, at about half the distance from the 2nd parallel to the most advanced saliants of the covert-way, the besieger constructs the demi-parallels O, consisting of trenches which intersect the prolongations of the capitals of the bastions and ravelin, and extend sufficiently to the right and left of these prolongations to meet those of the branches of the covert-way, as well as the prolongations of the flanks of the bastions. Troops chiefly composed of grenadiers are placed in the demi-parallels, who, besides protecting against sallies the trenches in front of these works, may also answer the musquetry fire of the place; being covered by sand bags forming crenels on the top of the parapet, in the

manner represented by the crenel *d (pl. 3, fig.* 11). The reverse of the demi-parallels likewise affords a convenient place for depositing the materials that the construction of the works in their front requires; and howitzer batteries *s* are established at their extremities, in order to enfilade the branches of the covert-way and the flanks of the bastions.

64.—The demi-parallels are generally commenced on the ninth night; the single-sap being used to construct them, unless circumstances allow the flying-sap to be employed at intervals. In the mean while, the sappers continue to push on the boyaux opposite the ravelins collateral to the front of attack; and, when arrived at the distance of about 100 yards from the saliants of the covert-way, they make upon the right and left of the last boyau on each side an amorce (45.) which, by being afterwards prolonged inwardly, will form part of the 3rd parallel; the sappers direct the outward extremity *t* of this amorce in such a manner that it may be flanked by the redoubt at the end of the 2nd parallel. At day break, the besieger completes such parts of the trenches carried on in the night as still remain in an unfinished state, and forwards the batteries s at the extremities of the demi-parallels.

During the ninth day, the besieger constructs the boyaux P which cross the prolongations of the capitals of the central ravelin and the two contiguous bastions, but does not advance nearer than about 80 yards to the saliant of the covert-way in front of this

ravelin; then, towards dusk, he makes amorces extended on both sides of the last boyau of each set, these amorces being traced in the direction that the 3rd parallel is to have. The single-sap is used to make them, or occasionally the flying-sap.

65—The requisite materials for proceeding to the actual construction of the 3rd parallel on the next night, should also be conveyed to the demi-parallels and the contiguous boyaux, in the course of the 9th day. In the evening, the guards of the trenches who occupy the abovesaid works are to be strongly re-enforced, and particularly by grenadiers; as well as those stationed at the extremities of the 2nd parallel, and in the amorces before mentioned (64) which are to form the ends of the 3rd parallel; these amorces having been made longer and wider during the day. Cavalry should also be posted behind the extremities of the 2nd parallel, so as to attack in flank and rear any sally which might attempt to penetrate into the intervals between this and the 3rd parallels.

66.—The 2nd and 3rd parallels commonly have the same profile; however, as the latter being much nearer to the works of the place than the former, is consequently more exposed to a plunging fire from them, it may occasionally be made rather wider and deeper, and its parapet higher. In order to construct it, the amorces previously made (64) opposite the central ravelin and the two contiguous bastions are prolonged to the right and left by means of the single-sap, those which face the rav-

elins collateral to the front of attack having their inward extremities produced towards the centre of the parallel. Eight brigades of sappers are therefore requisite for all these saps, which they carry on one towards another until they meet; and, as they will probably finish them in the evening of the 10th day, the eleventh night and the following day may be employed in completing the parallel*. Crenels should be made with sand bags (63) on the top of the parapet.

67.—The 3rd parallel being completed, and supplied with a proper number of troops, the besieger has much less to fear from the sallies: for, if they should venture to advance from the covert-way opposite the parallel, they would be exposed to a very destructive fire from this last; whilst, if in order to turn the parallel, they should advance upon its flanks, the guards of the trenches who are posted there would instantly be joined by the troops left for this purpose at the outward ends of the extreme demi-parallels, and at the ends of the 2nd parallel. New batteries A (*pl.* 4, *fig.* 21), the disposition and important objects of which will be hereafter explained, may also be safely constructed under the protection of the 3rd parallel. In short, this parallel facilitates the means to the besieger of storming the

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* Supposing that the fire of the place being not very brisk, the besieger has been able to employ the flying-sap occasionally in the course of the 10th night, the 3rd parallel may of course be completed sooner than abovesaid.

covert-way, whenever particular circumstances lead him to storm it. The reason is that the 3rd parallel affords a convenient place where the storming party, &c. may be assembled, and from whence the different corps which compose it may repair by the shortest road to those parts of the covert-way that they are respectively appointed to attack. But particularly in this case, such a portion of the parallel as is comprised between the prolongations of the capitals of each two ravelins should be made convex towards the opposite bastion and re-entering place of arms, so as to be nearer to them; care being taken however that its direction does not render any part of it liable to enfilade. Steps 36 feet long, or thereabouts, should likewise be constructed in the parallel, upon the right and left of the prolongation of every capital, in order to enable the storming troops conveniently to pass over the parapet, and to form at each passage a front sufficiently extended. It is proper too, that the parallel should be placed rather nearer than usual to the saliants of the covert-way in front of the ravelins; whilst the batteries A are to be erected as near the re-entering parts of the fortifications as can be safely done, so that their fire against them may prove more effectual.

CHAPTER IV.

THIRD PERIOD.

Disposition and important purposes of the batteries erected under the protection of the 3rd parallel: Storming of the covert-way: Circular parts: Double-sap: Cavaliers of trenches: 4th parallel: Crowning of the covert-way: Construction of the besieger's traverses: Counterbatteries and breaching batteries: Process for effecting breaches by means of artillery: Descents into the ditches: Passing of the ditches: Assault, &c. to the different works requiring this operation: Attack of the retrenchments of the bastions.

68.—The batteries A *(pl. 4, fig. 21)* which the besieger constructs under the protection of the 3rd parallel, might be erected within it; but it is preferable to place them at a small distance in its front, as, in this situation, they will not impede the movements of the troops, or be in the way of the approaches; whilst a direction more suitable for their intended purposes may also be given to them. The disposition of these batteries should allow them to enfilade the branches of the covert-way, as well as the faces and flanks of the works behind it; and howitzers are to be placed along the faces *d*, the circular portions *e* between these faces being occupied by mortars and stone-mortars. The fire of the stone-mortars is to be principally directed upon the re-entering place of arms and the branches of the covert-way; and if it should happen that the distance

exceeds the common range of these pieces of ordnance, which is about 140 yards, mortars loaded with grenades must be substituted for them.

69.— In consequence of the arrangement of the batteries A, such a number of shot may be poured into every work occupied by the besieged troops, as will annoy them at all points, render of scarcely any avail to them the uncovered batteries which they may still have, and even greatly impair the effect of their musquetry fire. The batteries A are also free from the inconvenience which those behind them have of giving uneasiness to the troops in the 3rd parallel, by firing over their heads; whilst they immediately protect the approaches in front of this parallel.

70.—The batteries just spoken of will probably be ready in the beginning of the 13th day; and, if it should be intended to storm the covert-way, a brisk fire must be kept up from them for the whole day before that operation is commenced, so as to destroy the palisades, tambours, and other means of defence which the besieged troops may have in the covert-way, and, if possible, oblige them to quit it. The guards of the trenches posted at the extremities of the 3rd parallel should also be strongly re-enforced, in order that they may effectually protect them against any sally which the garrison might send during the attack, for the purpose of disturbing the besieger and thus impeding his operation; and, after collecting on the reverse of the parallel, as well as in the boyaux behind it, the tools and materials requisite to *crown* the covert-way (71.) the troops for the attack and

the workmen should be assembled, the latter being supplied each with one gabion. The attack is to be carried on as follows:

In the evening, but with still sufficient light to allow the operation to be executed in good order, detachments of grenadiers should advance rapidly from the 3rd parallel to the crest of the glacis in front of the saliant places of arms, so as to throw a great number of grenades upon such troops of the garrison as may occupy them. Picked troops, proceeding also from the 3rd parallel, should instantly follow these detachments, and direct a brisk fire of musquetry upon the enemy in the branches of the covert-way; whilst sappers, with engineers at their head, are to cut down the palisades and barriers of this work, so that the storming party may enter it, charge with the bayonet those besieged troops who may attempt to defend it, and oblige them to retire into the re-entering places of arms. The storming troops should likewise fire upon any soldiers of the garrison whom they may see along the parapets of the opposite works; observing to keep watch over the pas de souris or other communications from the ditches to the covert-way, as an enterprising garrison might venture to return to this work, by means of the communications in question, in order to regain it*.

71.—The attack having succeeded, workmen are to set off instantly from the 3rd parallel, for the

* It must be acknowledged that the present disposition of the pas de souris and covert-way scarcely leaves any hope to the besieged troops of being able to regain this work, after they have lost it. However, bold troops might make such an attempt.

purpose of constructing in front of the saliants of the covert-way the lodgments *f* about 6 yards distant from these saliants, and which embrace them. The flying-sap is used to form the lodgments in question, and the workmen should fill the gabions speedily, in proportion as they are placed. In the mean while, other workmen are to execute the communications from the 3rd parallel to the lodgments.

As soon as circumstances allow it, part of the storming troops should avail themselves of every cover which they can find behind the traverses of the covert-way, the profiles of the sally-ports and the gabions of the lodgments above mentioned, so that being less exposed, they may more effectually support such other troops as are uncovered. These lodgments will in two or three hours be capable of containing a sufficient number of fresh troops to protect them, who should be sent from the 3rd parallel; after which, the troops employed for the attack are to retire gradually into this parallel.

It is also to be remarked that as the lodgments *f* may be enfiladed by the works of the place, and are even exposed to a reverse fire from them, they should be secured by traverses *g*, erected from distance to distance,* and have their extremities covered by strong epaulments. The besieger is to complete these lodgments during the night, and to forward such other works as are commenced, employing the single-sap whenever he cannot make use

* The particulars relating to the construction of the traverses which the besieger may have occasion to make, will be explained further on.

of the flying-sap; but all these operations would be attended with great danger to him, if he were not protected by a brisk fire from the batteries; on which account, the lodgments should not be at first extended much further along the branches of the covert-way, than is necessary to make them meet the prolongations of the faces of the ravelin and bastions; in this manner, their parapet will not impede the fire of the batteries; and, in order to render this fire more effectual, its proper direction should be ascertained and marked in day time, before the attack of the covert-way is commenced.

72.—The taking of the covert-way, by means of storming it, undoubtedly abridges the duration of the siege; and indeed, various defects in the present methods of fortifying towns, besides the powerful effect of the besieger's batteries in the actual improved state of the artillery, afford him a favourable chance of succeeding in the operation in question; but the loss of men on his side will be very great, if independently of the besieged troops being sufficiently numerous, they use proper precautions and defend themselves as they ought to do. Therefore, the storming of the covert-way is not advisable unless the small number and want of determination of these troops, and the feeble state of their means of defence in all other respects, remove every apprehension of the considerable danger to which the storming party would otherwise be exposed; or else,

when the near approach of a season unfavourable for the siege, or of any army coming up to raise it, indispensably requires that the besieger should hasten the operations, let the consequences arising from it in other respects be what they may. Under different circumstances, it is far preferable that he should advance gradually to the crest of the glacis, and the process usually employed for this purpose is such as follows :

73.—At the distance of 25 or 30 yards to the right and left of the intersection of the 3rd parallel with the prolongation of the capital of each saliant, two brigades of sappers push out from this parallel the saps *i* and *k*, which they carry on one towards the other until they meet; giving them a curved direction, so as to secure them from enfilade. These saps form what is called a *circular part*, and are subsequently widened so as to have the same breadth as the 3rd parallel; steps are made within them, in order to pass over their parapet, and crenels are formed with sand-bags on the top of the latter.

74.—The circular parts are generally commenced on the 14th night, and completed in the course of the following day. With respect to their use, the troops posted in them see in front the opposite branches of the covert-way, and the fire of each two circular parts crosses upon the ground between them. Besides, the circular parts afford

convenient places for the materials which the approaches beyond them require, as well as room for grenadiers who are within them suitably placed to protect against sallies the sappers &c. engaged in carrying on those approaches.

75.—In the evening of the 15th day (grenadiers being stationed in the circular parts, and the batteries keeping up an uninterrupted fire upon the covert-way and other works of the garrison) the sappers advance up the glacis in a direct line, from the middle of each circular part. They make for this purpose a *double-sap l*, consisting of two parallel single-saps *a* and *b* (Pl. 3. Fig. 17 and 18.) which have the usual dimensions of saps of this kind, but which are separated from each other by a mound of earth *c* called the *tongue*. The gabions of one sap are placed on the right hand, and those of the other on the left; so that after the mound of earth between the two saps is removed,* these form a trench at least 12 feet wide at top (not including the two berms) with a parapet on each side. In order to secure this trench the sappers construct traverses within it, similar to those *m* or *n* (Pl. 4. Fig 21;†) by

* The tongue *c* is removed by a working party purposely sent, who also make the trench deeper if this should be deemed requisite.

† The traverses *m* being constructed with greater convenience than the traverses *n*, should be preferred to them. They are called *lock-traverses*.

means of carrying on the saps round a mass of earth from 12 to 15 feet wide, and of such a length as allows it to cover the trench; they augment the height of the traverses by placing gabions on their tops, which they fill with earth.

It should be observed that whenever a double-sap is carrying on, the 1st sapper of each of the two single-saps must carefully keep pace with the 1st sapper of the other.

76.—At a smaller distance from the crest of the glacis than about 30 yards, the head of the double-sap pushed out from each circular part would not be sufficiently protected by the latter against sallies, besides being exposed to a quantity of hand-grenades which the besieged troops would throw upon the sappers from the opposite saliant place of arms.* It is therefore requisite that after the double-sap has been carried on to the aforesaid distance, the single-saps which compose it should change their directions, one to the right and the other to the left, so as to form a trench *o* embracing the saliant of the covert-way, and which is to be extended to the prolongations of the two branches. This trench is intended to contain troops, and close to its extremities *cavaliers of trenches p* are usually constructed, which, by

* Experience has shown that any soldier can throw a hand-grenade to the distance of about 26 yards.

raising the soldiers posted there, enable them to plunge their fire into the covert-way, in order to clear the saliant place of arms, as well as the contiguous parts of the branches, and prevent the garrison from returning to them. The cavaliers are interiorly secured from the fire of the collateral works by means of *returns q* the length and height of which are such as to allow them to answer the abovesaid purpose.*

To construct a cavalier of trenches (Pl. 8. Fig. 19.) supposing its requisite height over the glacis to be twice that of a gabion, besides the fascines, one row of gabions *a* is placed at the bottom of the trench, the tops of which are on a level with the berm, and consequently augment its breadth.† Upon the berm thus widened another row of ga-

* It was lately found that batteries, consisting of stone-mortars and mortars loaded with grenades, effectually answer the purpose of cavaliers of trenches, whilst much time and labour is saved by substituting the former for the latter. This disposition consequently affords material advantages, and particularly, when besides the saliant opposite the trench *o* being very wide, the collateral works also have a great projection beyond it; for, in this case, the construction of cavaliers of trenches is not only generally attended with considerable difficulties, but is sometimes impossible.

† If it should happen that the depth of the trench exceeds the height of the gabions placed at the bottom of it, fascines should be laid on their tops, so as to make them level with the berm.

bions *b* is formed, close to the row *c* which supports the parapet of the trench, so that each of the gabions *b* rests upon the berm and one of the gabions *a* in the lower row. Therefore, by placing a single row of gabions *d* over those *b* and *c*, the cavalier will have its proper height. But if it should be wished to make it one gabion higher, each course of gabions, including that in the trench, must be augmented by one row, and a single row be placed upon the whole.

The soldiers appointed to fire over the cavalier mount upon the banquette *e* by means of steps *f* leading to it from the bottom of the trench; and, in order that they may be more effectually covered, fascines are laid on the tops of the gabions in the upper row, which support loop-holes made with sand-bags or otherwise. The gabions of every row are of course to be filled with earth.

Whenever it is thought advisable that a fire should be kept up over the returns *q* (Pl. 4. Fig. 21.) which secure the interior of cavaliers, these returns should be made with steps and banquettes, similarly to the cavaliers; but under different circumstances, the steps and banquettes are useless.

The above method of constructing a cavalier of trenches supposes that the single-sap is used to commence it; but if the flying-sap should be employed, gabions are at first to be placed in two rows *a* and *b* upon the berm (Pl. 3. Fig. 20.)

and then successively filled with earth, beginning with the gabions in the row *a*; after which, the workmen are to throw in front of the gabions the earth supplied by the widening and deepening of the trench, until this earth being raised to a suitable height, they lay another row of gabions *c* upon the two former, and also fill these gabions. The remainder of the operation is to be performed in the same manner as for a cavalier began by the single-sap.

If it were found necessary to increase the height of a cavalier commenced by the flying sap, this may evidently be done by subsequently placing a row of gabions at the bottom of the trench, and augmenting each course of gabions by one row, &c.

Whatever may be the process used for constructing cavaliers of trenches, they require a length at least equal to the breadth of the covert-way; whilst their direction should be perpendicular to the branches of this work, provided however these branches do not form an obtuse angle, and the cavaliers are not exposed to any very dangerous reverse fire from the collateral works; for, under different circumstances, the cavaliers must be parallel to the branches, or nearly so.

77.—Admitting that no impediments may prevent the sappers from tracing the trench *o* (Pl. 4. Fig. 21.) in the 16th night, as well as the

the cavaliers *p* and the returns *q*, all these works will be completed at the end of the 18th night,* together with the 4th parallel B C which connects the cavaliers, if the besieger has deemed it expedient to construct this parallel; the single-sap is used to trace it, and it is connected with the 3rd parallel by means of the communications D which follow the prolongations of the capitals of the re-entering places of arms.

78.—Notwithstanding the advantages which under peculiar circumstances the 4th parallel may afford to the besieger, yet it should not be indiscriminately used; for, as the parapet of this parallel impedes the fire of the batteries of the 3rd, they must be transferred from the latter to the former, which operation not only occasions the loss of about two days, but enables the besieged troops to avail themselves of the kind of respite which they thus have, in order to make such dispositions as will allow their own fire to be revived. In general, no 4th parallel is constructed unless the ground between the ravelins being much re-entering, and the besieged troops making a vigorous defence, it becomes necessary to press closer upon them; or else, when the besieger intends

* The trench *o* will be completed before the cavaliers and returns, namely, on the 16th day; and grenadiers should be posted in this trench as soon as it is ready to receive them.

to storm the covert-way; in this case, as the 4th parallel is nearer to the covert-way than the 3rd, the storming party can gain the crest of the glacis in a shorter time, and is also protected from a small distance by the fire of the cavaliers, as well as by that of the batteries of the 4th parallel, &c. Whenever this parallel is made for the latter purpose, steps should be constructed within it, similar to those described (67.) in respect to the 3rd parallel. The necessary dispositions previously to the attack, and during its progress, are also to be the same for both parallels.

79.—A fire being kept up in the course of the 18th day, either from the cavaliers of trenches or the stone-mortar batteries substituted for them (see note* page 93.) the besieger will be able to advance in the 19th night to the distance of 6 yards from the saliants of the covert-way opposite the ravelin and bastions of the front of attack. He might for this purpose construct double-saps in the same direction as those between the circular parts *i k* and the trenches *o*; but it is preferable that he should make two double-saps *r* for every saliant, one on each side of the prolongation of the capital, beginning the excavation close to the cavaliers, and carrying it on in a straight direction towards the saliant, until the heads of the saps are at the aforesaid distance of 6 yards from it. The besieger is then to proceed to the crowning

of the covert-way; and, in order to begin it, two of the four brigades of sappers employed for constructing the double-saps *r* should turn to their right, and the others to their left, so as to form four single-saps, two of which, namely those inward, are to meet opposite the saliant, whilst the others follow a direction parallel to the branches.

80.—The 19th day and 20th night may enable the besieger to crown a large portion of the covert-way in front of the ravelin; but the proximity of the re-entering places of arms, besides the action of the ravelins, will render it scarcely possible for him to extend during that time his lodgments opposite the bastions, further than the prolongation of the magistral line of the faces of these works. In constructing the traverses *g* which are to secure these lodgments and those in front of the ravelin, the sappers should cautiously avoid placing any of them in those parts of the lodgments where they would interfere with the situations for the guns of the counter-batteries and breaching batteries that the besieger is subsequently to erect, as will hereafter be more particularly explained. The epaulments *h* require such a length, and such a height, as will allow them to secure the lodgments from the fire of the collateral works.

81.—The process to be used for constructing the traverses *g* is much the same as that described

(75) in respect to the traverses *m* and *n*. Therefore the sappers, after carrying on the trench as far as the place where any of those traverses is to be made, successively change direction, so as to turn at right angles round a piece of ground of the same length and breadth that the traverse must have; and, if the trench should happen to be exposed to a reverse fire, a kind of epaulment *s* is made in the rear of the traverse, its length and direction being such as to allow it to cover the passage behind the latter, besides answering the purpose of a parados. The height of all the traverses is of course increased by means of the gabions which the sappers place on their tops, &c.

82.—The usual process, for approaching the re-entering places of arms and crowning them, will now be explained:—Supposing that the besieger has made the 4th parallel B C, he advances from it, towards each re-entering place of arms, by means of a double-sap following the prolongation of the capital of this work, and which he secures by traverses; whilst after this sap has been carried on to the distance of 6 yards from the saliant, the sappers of one of the two brigades turn to their right, and those of the other to their left, so as to continue their work in a direction parallel to the faces, and thus crown them. But when the besieger makes no 4th parallel, he constructs opposite each re-entering

place of arms a concave trench E F, connected on both sides with the crowning of the covert-way, and places in the middle part of this trench a strong battery *t*, consisting of stone mortars and mortars to be loaded with grenades, the fire of which is directed against the re-entering place of arms, its redoubt and the bastion behind; as well as against the ravelin and the redoubt inside of it. From this trench the besieger pushes on two double saps *u*, which he directs straight towards the saliant of the re-entering place of arms; and, when arrived at the distance of 6 yards from this saliant, the sappers crown the faces in the manner explained (79) respecting the crowning of the covert-way in front of the bastions and ravelin.

It is proper that as soon as the besieger is lodged in front of both the saliant and the re-entering places of arms, he should establish batteries *v* composed of one or two howitzers, in order to destroy the *tambours** which the besieged troops usually construct for the purpose of covering the pas de souris at the gorge.

83.—The crowning of the covert-way will generally be completed at the end of the 22nd night, together with the concave trenches E F, including the batteries *t*; and, as the besieger was engaged since the 21st day in making the necessary preparations for erecting the other re-

* The description of tambours will be hereafter given (180).

quisite batteries, he will be able to commence on the 22nd day the counter-batteries *w* opposite the ravelin, as well as those *x* and *z* in front of the bastions; besides the batteries *y* situated in the prolongations of the counter-batteries *w*, and which are intended to breach the ravelin.

The counter-batteries *z* serve to keep down the fire of the opposite flanks of the bastions, as it would impede the besieger in effecting the passage of the principal ditch, and augment his danger in storming the bastions. They also see the breaches of these works, as well as the tenaille, the caponier or the bridge leading from it to the gorge of the ravelin, and even part of the curtain. In respect to the counter-batteries *x*, their object is to check the fire that the artillery of the flanks of the bastions collateral to the front of attack can keep up in an oblique direction against the counter-batteries *z*. Lastly, the counter-batteries *w* are intended, first, to silence the garrison's artillery placed along those parts of the faces of the bastions from whence it enfilades the ditch of the ravelin and the covert-way; but after accomplishing this purpose, they should breach the faces through the opening of the ditch in question.

84.—Unless there should be any particular reasons to the contrary, the counter-batteries and breaching batteries just spoken of are usually

placed as the Fig. shows; that is, they are established in the trench which forms the crowning of the covert-way, their epaulments consisting of the parapet of this trench, and their terrepleins being secured by traverses from the fire of the place in flank and in reverse. The terrepleins of the batteries *y*, and occasionally those of the batteries *w*, are elevated a little above the bottom of the trench, so as to allow the guns to be pointed nearer to the foot of the opposite escarp, and therefore in a direction more suitable for making a proper breach. But different circumstances may sometimes require that counter-batteries and breaching batteries should be constructed upon the terreplein of the covert-way, instead of in the crowning; for instance, they are to be placed in the former situation whenever the latter would render them liable to a reverse fire, and the besieger cannot construct traverses of such length and height as would be necessary to secure the batteries effectually; or else, when on account of the ditch in front of the work to be breached being narrow and very deep, it would be requisite, if the breaching battery were placed in the crowning of the covert-way, to raise its terreplein immoderately, in order that the artillery men may see the escarp sufficiently low down, to make a practicable breach; for, in this case, the guns should of course be propor-

tionally depressed, and therefore, their depression would exceed seven degrees; whilst guns loaded with full charges do not admit of being depressed more than this number of degrees.*

85.—It was said (83.) that the besieger begins the counter-batteries *w*, *x*, *z*, and the breaching batteries *y* on the 22nd day. He also traces on the same day the openings *a'* of the descents into the ditch of the ravelin, and commences the excavation in the course of the following night;

* The following method of breaching a work, by means of artillery, is generally used when the escarp has a revetment of masonry:—At first, the guns are loaded with full charges, and all pointed against the same part of the revetment, 6 feet or thereabouts above the bottom of the ditch when it is dry, and on a level with the water if the ditch contains any; and, as soon as the earth begins to come out through the opening thus made, the artillery-men gradually lengthen the aperture, by means of concentrating the fire of the guns upon its lateral extremities, until a kind of horizontal groove is formed equal in length to the requisite breadth of the breach; they then effect several vertical grooves in the same manner, extending from the horizontal one to the top of the revetment; after which, by directing the guns successively against each separate portion of the revetment between two vertical grooves, and firing all of them at once, with smaller charges, the strong commotion produced by the shot in that part renders it loose, and ultimately occasions its falling down into the ditch.

But if the escarp should only consist of a slope of earth, loaded shells are to be thrown into it in a horizontal direction, so that by exploding they may spread the earth, and thus facilitate the ascent.

besides forwarding the counter-batteries and breaching-batteries, the former of which being completed at the end of the 24th night, and supplied with their artillery, may therefore commence firing on the 24th day, in the morning; but the breaching-batteries will not be ready for action before the evening of that day, or perhaps, not before the next morning.*

Whilst the counter-batteries and breaching batteries are firing, the besieger continues the descents into the ditch of the ravelin, and collects near them the necessary materials to execute the works *b′* which form the passages across this ditch.

86.—By the descent into a ditch is meant a kind of gallery A (Pl. 5. Fig. 25.) leading from the glacis to the ditch,† opposite that part of the breach where it is intended that the storming party should mount; and, in order that the communication through this gallery may be convenient, the slope which it forms is not to be greater than about 2 inches per foot; the descent should consequently be begun at such a distance from

* It is supposed in the above calculation that the counter-batteries and breaching batteries are placed in the crowning of the covert-way; but if the besieger should be obliged to establish the latter on the terreplein of this work, they will only be ready in the course of the 26th night.

† The descents should meet the bottom of the ditch, or the level of the water, according as the ditch is dry, or wet.

the counterscarp, depending upon the difference of level between the extremities of the former, as will not require the above dimension to be exceeded; or, if the besieger should wish to commence the descent nearer to the ditch, and yet, without making it too steep, he may at first carry it on straight towards the counterscarp, as far as the tails of the counterforts, or thereabouts, and then continue it in a direction parallel to the ditch, until he gains the spot just opposite the place where he intends to cross it; after which, this direction is to be changed, so as to bring the descent exactly to that place. The descent *a′* (Pl. 4. Fig. 21.) is supposed to be made according to the former process, and the descent *c′* conformably to the latter. With respect to the method recommended by some engineers of constructing steps from distance to distance, so that those parts of the descent may be less steep which occupy the intervals between the steps, this method renders the communication through the descent very inconvenient, and should therefore be rejected.

When it is not requisite that the descent into a ditch should be sunk to any great depth, it may be made in the form of a trench, from 5 to 6 feet being allowed for its breadth;* and, in order to

* The communication through a descent less wide than 5 feet, would scarcely be convenient. The height of the descent requires 5 feet 6 inches at least.

secure it from the stones, grenades, and combustibles, which the garrison might otherwise throw into it, it should be covered at top with hurdles and fascines supported by a kind of frames that the French call *blindes*,* and upon which raw hides, or sand-bags and turf, are to be laid, so as to prevent the garrison from setting them on fire. But as a deep descent entirely made in this manner would require an immoderately large quantity

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* Blindes serve for different purposes, and are on that account variously constructed; but they all are made of timber; those represented by Fig. 29. Pl. 6. are used for the descents into ditches, and consist of two uprights *a*, *b*, generally 7 feet 6 inches long, which are pointed at both ends and connected together by two cross pieces *c* and *d*. The uprights and cross pieces are each 6 inches square, and the points of the former project about 1 foot beyond the latter; the width of the blindes, between the uprights, is 3 feet 6 inches.

When using these blindes, they are vertically placed in one row along each side of the descent, with an interval of 2 feet 6 inches between them, and the blindes on the right side exactly facing those on the left. Those parts of the descent which correspond to two opposite intervals, are then covered at top with other blindes laid flat, of the same dimensions as the former; excepting however that the distance between the cross pieces is greater, so that the points of the contiguous vertical blindes may pass through the angles which these cross pieces form inwardly with the uprights. All the blindes are kept steady in their position by means of pegs and brackets; and, gradually as the hurdles and fascines are placed on the top blindes, the raw hides or the sand-bags and turf are laid over them. (See Pl. 5. Fig. 25. and Pl. 6. Fig. 30 and 31.)

of earth to be removed, it is far preferable, after using the method in question for such a length *a b* of the descent (Pl. 5. Fig. 25.) as may conveniently admit of it, to construct the remainder *b c* under ground, like a gallery of mines. For this purpose, frames resembling a common window frame, and the dimensions of which are regulated according to the requisite height and breadth of the descent, are vertically fixed across it, the distance between them being generally 3 feet; and, in proportion as these frames are placed, planks are laid on their tops, as well as between each of their sides and the contiguous side of the descent, so that the earth above the frames, and along the sides of the descent, may be retained.

It was suggested that an expeditious means of gaining the ditch might be occasionally employed, without constructing any descent. This means consists in placing a mine strongly charged under the banquette of the covert-way, and disposing this mine in such a manner as to throw down the counterscarp and join the rubbish to that of the breach; so that after the explosion, the besieger may descend into the funnel* by sapping, and then gain the ditch.

87.—The descent into a ditch being carried on

* The funnel or crater of a mine is the excavation produced by the explosion.

as far as the back of the revetment of the counterscarp, an opening is made through this revetment* for the purpose of entering the ditch, so as to construct the necessary works for passing it. It is proper that a kind of recess of suitable dimensions should be made on the right and left of this opening, close to the back of the revetment, as, besides affording a convenient spot for depositing the materials that the construction of the besieger's works across the ditch requires, part of the troops appointed for the assault may be assembled there.

88.—The nature of the works which the besieger constructs for passing a ditch, depends upon whether it is dry, or wet. Supposing the ditch to be dry, a sapper avails himself of the opening made in the counterscarp, in order to throw into the ditch, on the side nearest to those parts of the fortifications which flank it, fascines and sand-bags, &c. which are passed to him from hand to hand. After having thus formed an epaulment capable of affording a safe cover, this sapper commences a single-sap behind it, which, as well the epaulment, is gradually carried on to

* If it should be intended to construct a descent, but to use a mine, instead of tools, for the purpose of making an opening through the revetment of the counterscarp, the miners should of course establish this mine, and set fire to it, before the descent is carried on so far as to meet the revetment.

the top of the breach. (See the passage *d* of the ditch Pl. 5. Fig. 25.) It has hereto been supposed that the ground at the bottom of the ditch admits of being conveniently excavated; but when it does not, either on account of its being rocky, or because water is found at a smaller depth than that which the sap is to have, then the besieger only constructs the epaulment.

89.—Either one or two passages may be made to gain the same breach, according to circumstances. The latter disposition is particularly advisable when the besieger expects to be strongly opposed by the garrison during the assault; for, two passages will allow a more numerous body of troops to mount together upon the breach, and therefore to carry on the attack with greater advantage.*

* Notwithstanding the reasons which have been urged in favour of assaulting breaches with small successive parties, namely, that no more men are exposed at one time than can enter the breach, whilst the parties, by gradually supporting each other, give as much strength to the attack as if it were carried on by a greater number of troops employed at the same time, yet the other method is undoubtedly preferable. For, large bodies of men, animating and encouraging one another, not only carry with them the confidence of success, but make a greater impression upon an enemy's mind, and therefore derive a double advantage from their number. Besides, according to the nature and object of an attack with small parties advancing one after the other, each of them is to remain

90.—It should also be observed that, although particular circumstances may occasionally allow the besieger to give the assault without securing himself in his advance to the breach by means of any works constructed across the ditch, yet this process is very seldom to be recommended, as it will probably fail, or at least be attended with a considerable loss of men to the besieger, if the besieged troops possess determination, and still have the means of keeping up any effectual fire from those parts of the fortifications which see the breach.*

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under cover until those before it have entered the work, or are beaten back; consequently, the first party has to sustain alone the brunt of the action, and to carry the work; or, if this party is repelled, the second, and successively the other parties, must advance under the discouraging ideas produced by the defeat of those before them; whilst the besieged troops acquire a new strength from being elated with their success. It is also very probable that although a strong column, capable of attaining its object speedily, might on the outset suffer a heavy loss, yet this loss will not exceed, or even be adequate to that arising gradually from the procrastinated defence which the repeated feeble efforts of the small parties would enable the garrison to make; besides the success of the attack being more certain. These arguments hold good in respect to escalading a work, which operation should therefore be executed with a sufficient number of ladders to enable strong parties to ascend at the same time.

* It follows from the observations made in the above paragraph, that, if the improper disposition of the fortifications

91.—The following process is used to pass a ditch containing stagnant water which the garrison cannot raise to a higher level:—Beginning at the opening of the counterscarp, fascines arranged in several beds, with small pickets driven through them, are sunk in the ditch by means of laying stones, earth, gravel, and other materials upon them; and gradually as the kind of bridge thus formed reaches the surface of the water, the epaulment is constructed upon it with sand-bags, fascines, or wool-bags. The two last kinds of materials require raw hides over them, so as to be secured from being set on fire by the garrison.*

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of any place has allowed a breach to be effected by a distant battery, and the besieger should venture to advance uncovered towards this breach, for the purpose of storming it, his success will be very doubtful. For, if, notwithstanding all the precautions that he will certainly take, the besieged troops should happen to perceive him in his advance, they will direct a destructive fire upon him; and the confusion likely to arise from it in his columns, will be augmented by the necessity of using ladders, or other means, to descend into the ditch. The attacking troops must then form in proper order, and make the requisite dispositions for the assault, being exposed to the effect of all the defensive means which the garrison may employ; so that after experiencing great difficulties, and probably a very heavy loss, these troops will have to meet an enemy ready to receive them.

* The breadth usually allowed for any bridge which forms the passage of a wet ditch, is from 30 to 36 feet; the epaulment occupies half of this breadth, or thereabouts.

The bridge and the epaulment being carried on as far as the breach, the single sap is used to gain its top, as in the case of a dry ditch.

92.—The ditches which present the greatest obstacles to the besieger in constructing the works necessary for passing them, are those which contain running water; or else, such ditches as the garrison may keep dry, or fill with water, at pleasure. The impediments arising from the nature of the latter are particularly great when by means of sluices accordingly disposed, a considerable quantity of water may be let in and out several times, in a rapid current. Difficulties also occur in constructing the passages of ditches filled with stagnant water that the garrison can raise to different levels; and all the above ditches require that the bridges used for crossing them should be floating, besides their strength allowing troops of infantry formed in a column to pass over them, as well as heavy artillery if it should be requisite to convey any. Such of these bridges as are liable to the effect of strong currents, ought likewise to be rendered capable of resisting that effect.

93.—The method of constructing the floating bridges in question (Pl. 4. Fig. 24.) consists in laying a proper quantity of fascines in beds which cross each other, and are fastened together with small pickets; upon every three or four beds, five

or six rows of joists from 4 to 6 inches thick are placed, in the direction of the length of the bridge; wooden pins 3 feet long, and pointed at both ends, are at every 4 feet fixed through the joists, these pins projecting equally on each side, and being driven into the fascines above and below the joists, for the purpose of consolidating the work. In proportion as the bridge advances towards the place, the besieger secures it by means of anchors on the side next to the current; and when the force of the water is great, he also drives piles along the other side. The cable of each anchor is folded in two, and fixed at one end to the joists nearest to the current, whilst the other end is fastened to a strong picket upon the top of the bridge; in such a manner, that as these cables may be veered out to any requisite length, the bridge can be raised or let down, according to the level of the water. As soon as any part of the bridge is completed, the besieger constructs the epaulment upon it with fascines, or wool-bags.

94.—It was suggested, as another method of effecting the passage of a wet ditch, that a raft with an epaulment upon it might be constructed along the counterscarp, and then wheeled round, so that one of its extremities being close to the descent, the other may reach to a sufficient distance from the rubbish of the breach to prevent its impeding the manœuvre for placing the raft in

the proper direction; the space between the raft and this rubbish is to be passed over by means of beams of a moderate thickness, which are laid across; and, like the floating bridge just spoken of, the raft may in case of a strong current be secured in its position with anchors and piles. In some circumstances a bridge of pontoons, carrying an epaulment of a suitable height and which consists of several rows of gabions filled with wool, may also with proper precautions be used to gain the breach; whilst in others, the besieger will perhaps have it in his power to destroy the batardeaux and sluices of the garrison with his artillery, or to let the water out of the ditch by means of cutting channels in the ground. In short, the engineer who is to direct the operation of passing a wet ditch, should decide upon the measures which may best answer this purpose, in consequence of the localities and the nature of the defence that the besieged troops still appear willing to make, and capable of making.

95.—As the particulars explained in the last paragraphs respecting the usual process for constructing the descents into the ditches, and executing the works necessary for passing the latter, may have diverted the attention of the Reader from the subjects previously treated of, it is proper to remind him in this place, before continuing the account of the besieger's operations, that the excavation of the descents into the ditch of the

ravelin was begun in the 23rd night, (85.) and afterwards carried on without any interruption.

96.—When the besieger intends to construct recesses (87.) on the right and left of the descents into the ditch of the ravelin, he begins them in the 25th night. He also makes during that night the openings through the counterscarp, so as to commence the works across the ditch in the 26th night, and complete them if possible in the course of the 26th day;* which of course depends on their nature, and the manner in which the ditch is defended. It is scarcely necessary to observe that the workmen employed in constructing these works, should be protected by the besieger's fire directed upon the top of the breach, so as to keep the besieged troops from it, and thus prevent them from annoying the workmen.

* The besieger is also to reconnoitre the breach during the 26th night; whilst in the course of the 26th day, he should render the ascent easier by means of throwing a great number of shells from howitzers upon the top and uneven parts of the breach. It is proper, likewise, that some of the sappers should in the following night smooth the ascent and remove such fragments of the revetment as would be in the way of the storming troops.

Whenever there is any appearance of the garrison's having retrenchments in a work which the besieger intends to storm, he should endeavour, whilst reconnoitring the breach, to gain the top unperceived, so as to ascertain the nature and particular disposition of those retrenchments.

97.—All the requisite dispositions for giving the assault to the ravelin, will probably be completed at the end of the 27th night; therefore, on the 27th day, the storming party should at daybreak cross the ditch rapidly, and ascend in the same manner upon the breach, so as to drive the besieged troops from the saliant, and oblige them to retire into the redoubt, as well as behind the coupures, of the ravelin; sappers, with engineers at their head, are to follow the attacking troops for the purpose of constructing under their protection, by means of the flying-sap, the lodgment *d'* round the circular part of the counterscarp of the redoubt, which lodgment they should connect with the passages of the ditch; and the troops are to retire into it in proportion as it is capable of receiving them.

98.—The besieger is to employ the 28th night in extending the lodgment *d'* as far as the ditch of the coupures of the ravelin, preparing fougasses to destroy their counterscarp, and carrying on the saps *e'* inside of the parapet of the ravelin, in the direction of its length, so as to advance to the rear of the redoubts of the re-entering places of arms, and see them in reverse. In the mean time, he should gain the ditch of the body of the place through that of the ravelin, his approaches consisting of boyaux *f'*, and descend into the re-entering places of arms by means of large coupures *g'* leading to the pas-

sages between their traverses and the glacis. Then, if the redoubts of the re-entering places of arms still oppose any resistance, the besieger, after crowning their counterscarp, is to make other coupures *h'* in order to descend into the ditch and construct mines for opening the escarp.

Whilst the besieger is engaged in executing all these works, the breaching batteries of the bastions should keep on firing against them.

99.—With respect to the method of executing the saps *e'*, the narrowness of the space where they are made does not allow their breadth to be but little more than 3 feet; their depth is 4 feet, and the sappers cover themselves on the right and left with sand-bags, instead of gabions. Three sappers are employed to carry on each of these saps, and, as they excavate, they throw the earth behind the sand-bags. The 1st sapper digs the ground for 2 feet in breadth and depth; the 2nd augments both these dimensions by 1 foot, and the 3rd sapper completes the work. The soldiers then make a kind of banquette with sand-bags, and arrange by hand those on the top of the parapet, so as to form loop-holes. The saps in question are carried on in the night, and advance 9 feet, or thereabouts, in each hour.

100.—In the 29th night, the besieger should work with the greatest activity at the batteries *i'* placed on the terreplein of the ravelin for the pur-

pose of breaching its redoubt, and complete the mines intended to open the escarp of the redoubts in the re-entering places of arms, as well as those which are directed against the coupures of the ravelin; after firing all these mines at day-break, he should give the assault to the latter redoubts, and establish himself inside of them.* The boyaux f' in the ditch of the ravelin are to be continued in the meanwhile.

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* If whilst the besieger expects to meet with a great resistance from the garrison in passing the principal ditch and storming the bastions, the breaches made in these works, through the ditch of the ravelin, should happen not to have such a width, or such a disposition in other respects, as would sufficiently facilitate the assault, new breaching batteries n' are to be erected at the gorge of the redoubts of the re-entering places of arms, immediately after these redoubts are taken, in order to enlarge the breaches previously effected. Counter-batteries o', consisting of two or three guns, may also be established in the redoubts, for the purpose of keeping down the fire of the tenaille and curtain.

Instead of constructing the batteries n', the besieger may, according to circumstances, make new breaches in the faces of the bastions, by means of the batteries p' which he erects close to the traverses of the re-entering places of arms, as soon as he has taken these works.

Such descents into the principal ditch as may be requisite in consequence of the breaches made by the new batteries above mentioned, should be commenced at the same time as the batteries themselves, and speedily pushed on, so as to delay as little as possible the construction of the works for the passage of the ditch.

101.—As the batteries intended to breach the redoubt of the ravelin will be finished in the 30th night, they may open their fire at day-break; and whilst they are firing, the besieger should consolidate his lodgments *k'* in the redoubts of the re-entering places of arms, accelerate the construction of the boyaux *f'* and gain the ditch of the redoubt of the ravelin, through that of the coupures.

102.—In the 31st night, whilst the besieger continues breaching the redoubt of the ravelin, &c., he should also enter the principal ditch, and commence the works *l'* across it. At day-break, it will be in his power to give the assault to the redoubt of the ravelin, and therefore, to begin the lodgment *m'* inside of this redoubt, so as to complete it in the course of the day.

103.—Supposing the works *l'* across the principal ditch to be completed at the end of the 33rd day, as well as the breaches in the bastions, every other requisite preparation for giving the assault to these works should be attended to in the course of the 34th night, and the assault given at day-break. In order to execute this operation, the troops appointed for it should gain the ditch and rapidly form in good order behind the epaulments constructed across it, so as to ascend the breaches and briskly attack the enemy on the terrepleins. In the mean while sappers, directed by engineers, are to form with every possible

speed the lodgments q' (Pl. 4. Fig. 21. and Pl. 5. Fig. 26.) upon the tops of the breaches, so that the storming troops may gradually retire into these lodgments, in proportion as they are capable of affording them cover. The remainder of the day should be employed in consolidating the lodgments in question, and connecting them with the works thrown up for passing the ditch.*

104.—In the evening of the 34th day, the besieger should advance beyond the lodgments q', in order to gain the counterscarp of the retrenchments, and crown it by single-sap. He is to work on the 36th day at the batteries r' intended to breach the retrenchments, or at such mines as he may prefer employing for this operation.†

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* The constructing of the lodgments q' supposes that the bastions are retrenched; but if they were not, the first divisions of the storming troops should take post along the edge of the interior slope of the rampart, immediately after driving away those of the garrison, and be joined by the next divisions in order to form a front sufficiently extended to cover and protect such other troops as are to enter the place through the breaches. These troops should file off behind the former, and cautiously follow the rampart to the right and left for the purpose of gaining the different posts which they are to occupy, and opening the gates, so as to enable the cavalry to come in.

† If any material inconvenience, in respect to the besieger's lodgments within the bastions, should be apprehended from the fire of the coupures s', batteries t', consisting each of two howitzers, may be established at the circular part of the coun-

105.—The besieged troops having no longer the means of making any resistance advantageous to them, will probably capitulate on the 37th day, in the morning, so as to avoid the consequences of the assault being given to the retrenchments, and obtain desirable conditions which would not otherwise be granted.* Therefore, the duration of the siege of a place fortified according to the Modern Bastion System (without any local or other advantages which augment its strength, and the nature of the polygon allowing the attacks to be carried on against one ravelin and the two collateral bastions) may in general be estimated at 36 days, from the opening of the trenches;† but

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terscarp of the redoubt of the ravelin, for the purpose of throwing loaded shells into that part of the parapet of the faces of the bastions, which stands behind the coupures. These shells will by exploding form an opening through the parapet, and thus allow the besieger to see the coupures in flank and in reverse. The epaulments *v'* may also be constructed with steps, and loop-holes be made on their tops with sand-bags, so as to enable the besieging troops to fire upon those of the garrison who occupy the coupures.

* The besieged troops may certainly come to a resolution not to capitulate before the assault is given to the retrenchments of the bastions, but this circumstance must arise from particular motives unconnected with the duration of the defence which the fortifications afford them the means of making o advantage.

† If the bastions should not be properly retrenched, the

if instead of surrendering before the assault is given to the retrenchments of the bastions, the garrison should be determined to withstand it, the taking of the place will of course be delayed for all the time necessary to breach and storm those retrenchments.

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garrison would be obliged to capitulate as soon as the besieger has secured his débouché into the ditch; that is, about the 31st day after the opening of the trenches.

CHAPTER V.

An investigation of the influence which the opening of the angles of any fortified polygon has upon its strength: Best method of carrying on the attacks, supposing the polygon to be of a superior order: The particulars of this method explained: Superior properties of a fortification consisting of several fronts disposed in a straight line, or placed on a concave curve.

106.—In proportion as the opening of the angles of any fortified polygon is greater, the relation of defence between the front of attack and the collateral fronts is more immediate, on account of the latter being less oblique in respect to the former; and therefore, the absolute strength of the front of attack is improved. The flanked angles of the bastions are wider, and may be so open, according to the nature of the polygon, as to render it extremely difficult, if not impossible, for the besieger to enfilade the faces; as happens when the prolongations of these last meet the faces of the ravelins, and are consequently intercepted by them. Besides, the ravelins cover the body of the place more effectually; and the besieger's works beyond the 3rd parallel are more

exposed to their fire in flank and in reverse; without speaking of several other circumstances which also are to the advantage of the besieged troops.

The various effects produced, by the opening of the angles of the polygon being greater, begin to be sensibly felt in the octagon; on which account this polygon, but particularly those above it, do not, like the inferior polygons, admit of the attacks being only directed against one ravelin and the two contiguous bastions. The reason is that the increased action which the ravelins collateral to the front of attack have upon the flanks of the besieger's works, does not allow him to crown the saliants of the covert-way opposite the bastions, without previously attacking these ravelins; as otherwise his cavaliers of trenches and his counter-batteries would be liable to such an enfilading and such a reverse fire from them, that their construction is in theory considered as impossible. It is therefore requisite that the 3rd parallel should be made sufficiently long to embrace two bastions and three ravelins; and consequently, the length of the 1st and 2nd parallels must be proportionably augmented.

But the above method of attacking polygons of a superior order evidently requiring considerable labour, whilst it also has the inconvenience of being attended with great danger to the besieger,

he should in preference direct the attacks against two ravelins and the intermediate bastion, as the collateral bastions projecting much less than two ravelins in the same situation, will have a smaller action upon the flanks of his works. The particulars of this method of carrying on the attacks shall now be explained, the polygon being supposed to be a dodecagon.

107.—Until the 3rd parallel A B is made (Pl. 6. Fig. 27.) no material difference is requisite in the method of carrying on the attacks, whether they are directed against one ravelin and the two collateral bastions, as is done in respect to polygons inferior to the octagon, or against one bastion and the two ravelins contiguous to it; with the exception, however, that for greater expedition and security, those parts *a* of the communications with the 3rd parallel, which immediately lead to it, should, in the latter method, consist of direct double-saps; and, as the central communication is not to be pushed on further than those in the direction of the capitals of the ravelins, the 3rd parallel is straight, or nearly so. But the prolongations of the faces of both the attacked bastion and the bastions nearest to it passing more close to the saliants of the ravelins than those of the faces of bastions belonging to an inferior polygon, the besieger's 1st batteries cannot so effectually enfilade them. The besieged troops

have it therefore in their power to defend the ground along the prolongations of the capitals by such a fire as must undoubtedly retard the besieger in his advance.

108.—Conformably to this observation, the 3rd parallel will probably not be completed before the 12th night. The besieger should then commence the batteries *b* and *c**, consisting of howitzers and mortars; their object is to enfilade the faces of all the works which compose the front of attack, and to annoy the garrison in every part of the terrepleins. The gun batteries *d*, which are to serve as counter-batteries against the faces of the bastion, should also be begun as soon as the 3rd parallel is terminated.

109.—The batteries just spoken of being ready for action on the 14th night, the circular parts *e*, in front of the bastion and ravelins, should be commenced in the same night; as well as the two double saps *f* directed each towards the salient of the opposite re-entering place of arms.

110.—From the circular parts *e* the besieger advances up the glacis, by means of double-saps, until being arrived at the distance of 30 yards

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* If time and other circumstances should allow the besieger to erect the batteries *b* before the 3rd parallel is completed, he certainly ought to do so; but it is supposed in the above paragraph that he is obliged to delay constructing them until he has finished this parallel.

from the saliants of the covert-way in front of the ravelins, he constructs the circular trenches *g* (76.) with the cavaliers of trenches *h* at their extremities; or, if on account of the fire in flank and in reverse to which these cavaliers are liable, the besieger cannot construct them, he substitutes for them stone mortar batteries covered by high and strong epaulments. All these works are generally completed in the course of the 18th night.

111.—The next operation of the besieger, (which he commences on the 19th night) consists in connecting the cavaliers of trenches, or the stone mortar batteries constructed instead of them, by a 4th parallel C D convex towards the saliant place of arms in front of the bastion; stone mortar batteries *i* are then established within this parallel, for the purpose of directing a heavy fire from them upon the three opposite places of arms and such other parts of the fortifications as may by their distance allow it; in the meanwhile, the besieger also completes the communications from the 3rd parallel to the 4th, &c.

112.—The sappers who carry on the double-saps *k* to be pushed out from the circular trenches *g* (79.) will in general circumstances be able to gain in the 21st night the spot for the crowning of the saliants of the covert-way in front of the ravelins (79.) and to crown these saliants in the

same night. The trenches made for this purpose should be extended as far as possible beyond the prolongations of the faces of the ravelins, and secured by means of proper traverses and parados.

113.—From the beginning of the 22nd night to the end of the 23rd day, the besieger is engaged in making the coupures *l* in the glacis, so as to gain through them the terreplein of the saliant places of arms opposite the ravelins, and in executing the crowning *m* of the counterscarp of these works. He also commences the batteries *n* intended to breach the ravelins; as well as those *o* and *p*, the former of which are to serve as counter-batteries against the bastions collateral to the front of attack, whilst the latter should be employed in breaching the attacked bastion, through the ditch of each ravelin, after being first used as counter-batteries against this bastion (83.) In short, the besieger begins the 5th parallel E F which connects the extremities of the crowning of the saliant places of arms before the ravelins.

114.—In the 24th night, the besieger continues to construct the batteries *n*, *o*, *p*, as well as the 5th parallel E F, the direction of which should be rather concave; and, whilst he is proceeding with them, he likewise makes the communications *q* which lead from the 4th parallel to the 5th; besides arranging stone mortar batteries *r* within

the latter. All these operations will be completed in the course of the 26th night, for the latest.

115.—The batteries *n*, *o*, *p*, *r* having commenced their fire on the 26th day, the besieging troops erect in front of the 5th parallel cavaliers of trenches *s* upon the prolongations of the faces of the three opposite places of arms, and connect them by trenches *t* in which stone mortars may be established for the purpose of throwing stones or grenades into the covert-way, the ravelins and their redoubts, if the fire of any of these works should happen to prove materially inconvenient; or, when the fire of the place is such as not to allow the cavaliers in question to be erected, the besieging troops sometimes construct circular parts (73.) in advance of the 5th parallel, and push out double-saps from them in order to gain the saliants of the three places of arms above-mentioned, so as to complete the crowning of the covert-way; whilst at other times, these troops do not make any circular parts, but advance to the saliants by means of double-saps only, which they carry on from the 5th parallel.

The crowning of the covert-way being completed, the besieging troops proceed to the construction of the counter-batteries *u* directed against the flanks of the bastions collateral to the front of attack.

116.—The interval between the 27th day and

the 31st night is generally sufficient to allow the besieger to complete the counter-batteries *u** and make the coupures *v* leading to the terre-plein of the re-entering places of arms, so as to crown the counterscarp of their redoubts, &c. and prepare the requisite mines (98.) for breaching these works. The same interval also enables him to open the counterscarp of the ravelins, and commence the passages *w* across their ditch.

117.—From the beginning of the 31st night to the end of the 32nd day, the besieger employs himself in finishing the passages across the ditch of the ravelins; and he also commences during that time the boyaux *x* within this ditch.

All the requisite arrangements for storming the ravelins should be made in the course of the 33rd night, so that the assault may be given the next morning, at day break. The mines intended to breach the redoubts of the re-entering places of arms are also to be fired at the same time, and these redoubts stormed. The besieger should then form his lodgments *y* and *z* upon the terrepleins of both the ravelins and the redoubts in question.

118.—On the 34th night, the besieger is to commence the batteries *a'* intended to breach the

* The counter-batteries *u* will be able to open their fire on the 29th day, towards evening.

redoubts of the ravelins; and, whilst he is engaged in constructing them, he should also improve the breaches of the bastion and begin the passages *b'* across the principal ditch. The breaches of the redoubts will be practicable in the course of the 37th night; so that the besieger should storm them the following morning, and establish his lodgments *c'* within them.

119.—After terminating in the 39th night all the necessary preparations for giving the assault to the bastion, it should be given on the 39th day, as soon as day-light appears.

120.—Similarly to the process used in the attack of an inferior polygon, the remainder of the besieger's operations consists in forming and consolidating his lodgments *d'* on the tops of the breaches of the bastion; as well as in crowning the counterscarp of the retrenchment, and either erecting the batteries *e'* which are to breach this work, or making the requisite mines to accomplish that purpose; and after he has accomplished it, he should storm the retrenchment if the garrison still persists in defending it. But as the larger size of the bastion allows it to be more strongly retrenched than in the case of an inferior polygon, whilst the besieged troops being more numerous may also impede the besieger's progress to greater advantage, the capitulation probably will take place only on the 44th day, or

perhaps some days later; depending on the more or less spirited and successful manner in which the garrison may have opposed the besieger, within the bastion.

121.—The preceding illustration of the method of carrying on the attacks against one bastion and the two collateral ravelins, instead of directing them against one ravelin and the two bastions contiguous to it, evidently shows that whenever the nature of the polygon obliges the besieger to use the former process, he meets with much greater difficulties than if it were in his power to employ the latter, and is also liable to a more considerable loss of men; which accounts for the longer duration of the siege.

122.—From the increased influence which the greater opening of the angles of fortified polygons has upon their strength (106) it evidently follows that, if several fronts are disposed in a straight line, results still more beneficial to the defence will be obtained. A fortification of this kind requires, similarly to the polygons of a superior order, that the actual front of attack should consist of two ravelins and the intermediate bastion; but the capitals of the ravelins being then parallel, the protection which these works afford to those behind them, and to each other, is still more effectual than in the case of a polygon; in such a manner, that the ravelins collateral to the

front of attack not only command the cavaliers of trenches erected opposite the ravelins of this front, but see in reverse the besieger's lodgments at the saliants of their covert-way; which obliges him to attack the collateral ravelins also. Besides, most of the besieger's principal trenches must have a direction parallel to that of the front of attack, or very nearly parallel, so that they may be secured from enfilade; and therefore, they have not the advantage of embracing the works of the place; whilst the prolongations of the faces of the bastions being intercepted by the ravelins, and even passing out of the sphere of the attacks, cannot be enfiladed. In short, the besieger is obliged to construct his counter-batteries and breaching-batteries upon the terreplein of the covert-way, so as to secure them from the reverse fire to which they would be subject on the crest of the glacis; and, in advancing between the ravelins, he is surrounded, in a narrow space, by a quantity of fire converging upon that space, from both the front of attack and the collateral parts of the fortification.

It should likewise be observed that, in order to secure the boyaux from being enfiladed, the angles which they form are to be less open than in the attack of polygons, and therefore, a greater number of boyaux must be constructed; which of course augments the labour of the besieger,

and consequently retards his progress. It is calculated that a fortification of the nature of that above described, should be capable of holding out 50 days at least, from the opening of the trenches; and that the garrison may defend it 60 days, by making a proper use of covered batteries.

123.—When several fronts are constructed upon a concave curve, they are considered as being actually unattackable; for, if the besieger should direct his attacks against one of the fronts at the extremities of the curve, the fronts, at the other end, would see him in reverse, and the central fronts in flank; and if he attacks any of the central fronts, he will be surrounded, after he has reached the spot where the demi-parallels are to be constructed, by a quantity of fire. bearing upon him in front, in flank, and in reverse, which crosses over the whole of his works without his having any means of securing them from its effect. It will not only be out of the besieger's power to enfilade the faces of the bastions, but the extremities of the curve may sufficiently project beyond the centre, to prevent him from enfilading the faces of the ravelins; and, as he occupies the central position of this curve, upon the periphery of which the fortification is placed, his fire will of course be diverging, whilst that of the garrison will converge upon the attacks.

CHAPTER VI.

*On the attack of Places destitute of Tenailles and Ravelins: An illustration of the process to be used in attacking a place fortified according to Vauban's 1st System: Vauban's 1st System and the Modern Bastion-System compared: Observations on Vauban's 2nd and 3rd Systems, commonly called the Tower Bastion-Systems: Method of attacking places constructed after these Systems: Remarks on Coehorn's Systems, and an explanation of the nature of the attacks suitable to a place fortified according to his 1st System.**

124.—Old fortresses are still found, which have neither tenailles nor ravelins, and where the bastions are small. The resistance that such fortresses are capable of making is very short; for, the ground along the prolongations of the capi-

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* The plates relating to the methods of attacking places destitute of tenailles and ravelins, as well as such other places as are fortified after Vauban's 1st, 2nd, or 3rd systems, or according to the systems of Coehorn, have been omitted in this Treatise in order to avoid the inconvenience of the considera-

tals being but feebly protected by the fire of the place, the besieger can carry on the approaches speedily, until he has gained the foot of the glacis; whilst he scarcely has any difficulty in securing all his works on the glacis from the fire of the fronts collateral to the front of attack, since (whatever the polygon may be) those fronts do not see the abovesaid works in reverse, or in any other direction materially dangerous for them.

Any place of this description allowing the 3rd parallel and its batteries to be completed in the 10th night for the latest, the cavaliers of trenches, &c. may be entirely finished in the 12th night, and the whole covert-way crowned in the 14th night. The breaching batteries and the counter-batteries will therefore be able to open their fire in the 16th night; the former are to breach both the curtain and the shoulders of the bastions, in order to allow any retrenchments which the bastions may have to be turned; and, as all these breaches, &c. will probably be effected in the course of the 18th night, a general

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ble expence which the insertion of those plates would have occasioned. But a complete description of all the abovesaid systems will be found in the Author's Treatise on the general principles of Permanent Fortification, &c. page 113, 152 and 167.

assault may be given on the next morning, at day break.

125.—The tenailles and ravelins which Vauban constructs in his first system, but particularly the latter, undoubtedly allow the places fortified according to that system to make a longer defence than those just spoken of. The reason is that in consequence of the cross fire which the ravelins afford upon the prolongations of the capitals, the ground along these prolongations is more effectually protected, and therefore the besieger cannot push on the approaches so speedily; the construction of the cavaliers of trenches, &c. is also attended with greater danger to him, and requires a longer time; whilst his lodgments in front of the saliants of the bastions being liable to an oblique and an enfilading fire from the collateral ravelins, he is more exposed in erecting the counter-batteries opposite the flanks of the bastions, and wants a longer time to make them. But still, the projection of Vauban's ravelins being small, and these works being destitute, as well as the re-entering places of arms, of redoubts so contrived as to improve the defence materially, the duration of the siege will not be considerably augmented, as is shown by the following particulars respecting the attack of a place fortified after the system in question.*

* The small projection of Vauban's ravelins evidently affords

The 3rd parallel and its batteries will be completed in the 12th night, and the cavaliers of trenches commenced on the 14th night. Likewise, as the re-entering places of arms have no proper redoubts, and the small projection of the ravelins enables the besieging troops to embrace conveniently at one time the three saliants of the front of attack, the whole covert-way will be crowned, &c. in the 18th night. The besieger may therefore on the 19th day begin the counter-batteries and breaching batteries, &c. observing to descend upon the terrepleins of the re-entering places of arms, so as to construct batteries there for the purpose of breaching the shoulders of the bastions, as well as the curtain through the openings between the profiles of the tenaille and the flanks of the bastions;* all these batteries will commence their fire on the 21st day, so that the breaches, &c. will be completed in the course of the 23rd day; and as those in the curtain allow the retrenchments of the bastions to be turned, the garrison will then probably capitulate, not

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the means to the besieger of securing his works between them from their fire, without any great difficulty.

* If the besieged place should be small, it will be unnecessary to erect a breaching battery in each re-entering place of arms, as one battery will be sufficient.

having the means of effectually withstanding the general assault which may be given.*

126.—By examining the nature of the attack suitable to a place fortified after Vauban's 1st system, and comparing with it the process to be used in attacking a fortress constructed according to the modern bastion-system, it will be seen that the considerable degree of superiority which the latter system has over the former chiefly proceeds, first, from the much greater projection of the ravelins, as it materially improves their action upon the besieger's works, and therefore obliges him to employ a longer time in constructing them. The direction of their faces also enables them more effectually to cover the shoulders of the bastions, as well as their flanks; and, in common with the redoubts of the re-entering places of arms, they prevent the besieger from breaching the curtains through the openings between the profiles of the tenailles and the flanks of the bastions. The retrenchments of the bastions being thus se-

* The disposition of the retrenchments of the bastions might happen to be such as to secure them from being turned by means of the breaches made in the curtain, (see the explanation given in the 2nd part of this Treatise respecting the various methods of retrenching bastions) and, in this case, the duration of the siege will of course be augmented by the necessary time to attack the retrenchments.

cured, the besieged troops are enabled to withstand the assault to greater advantage, and with less danger; not only on account of the protection which they receive from the fire of the retrenchments, but because these works afford a safe retreat to them, in case of necessity. The strong redoubts constructed in the ravelins, likewise increase the besieger's difficulties, as independently of the other very useful purposes which they answer, their flanks see in reverse any breach that he may make in the faces of the bastions; whereby he is obliged to take these redoubts before he could give the assault to the bastions.* Besides, it is to be observed that even in small polygons, the modern bastion-system does not allow the besieger to form his lodgments at one time opposite the three saliants of the front of attack, with as much convenience as Vauban's 1st system does in larger polygons; whilst the great effect produced by the ravelins, their redoubts and the substantial redoubts of the re-entering places of arms, renders it impossible for him to crown the whole covert-way by a single

* Even supposing that the besieger might be able to give the assault to the bastions before he has taken the redoubts of the ravelins, the fire from the flanks of these redoubts would at all events render this operation more dangerous for him.

operation. In short, all the principal works composing the modern bastion-system must be separately taken one after another; and, in Vauban's 1st system, the ravelins and bastions may be stormed at the same time.

127.—In contriving his 2nd system, and subsequently his 3rd system, which is an improvement of the 2nd, Vauban had for his object to rectify the following defects of the methods of fortifying places (his 1st system not excepted) that had till then been used; namely, all those parts of the fortifications, the disposition of which allowed the besiegers to take their prolongations with convenience, were liable to ricochet fire, and most of the defensive means of the garrison were destroyed when the near defence commenced. There remained no effectual fire to defend the terrepleins of the exterior works, and no sufficient quantity of artillery to protect the principal ditch; whilst the small extent of the terrepleins did not allow such retrenchments to be constructed upon them, as would have been necessary to secure the retreat of the besieged troops, and enable them to attack those of the besieger within the works where they had penetrated. The fortresses were therefore generally surrendered before the assault was given to the body of the place, so as to avoid the dreadful consequences that might have resulted from a longer resistance.

In order to rectify the above defects, Vauban imagined to construct in front of the body of the place counterguards in the form of wide bastions, which, with suitable retrenchments, would enable the garrison not only to withstand the assault, without being on this account subsequently exposed to any dangerous consequences, but also to attack the enemy to advantage in the counterguards; between each two of these works there is a large tenaille, which, similarly to them, is separated from the body of the place by a ditch; and, to defend this ditch, Vauban made casemated batteries so situated as not to be liable to be destroyed by any batteries erected either on the crest of the glacis, or on the terreplein of the covert-way. In short, this eminent engineer disposed the body of the place in such a manner that it might be secured from ricochet fire; and he besides improved the ravelins and communications, &c.

128.—Vauban's arrangement, considered in a general point of view, is extremely well contrived; and especially in his 3rd system, which being as aforesaid an improvement of the 2nd, of course contains his latest ideas. The body of the place is almost entirely covered by large exterior works which consequently afford sufficient room for such retrenchments and other interior dispositions, as are necessary to enable the garrison to

make an active and obstinate defence. The besieger is then obliged to give the assault to those works and carry on the attacks within them, under circumstances highly unfavourable to him; whilst, after taking them, it is still requisite that he should take the body of the place, as it is entirely separated. Besides, the ravelins having a greater projection than those in Vauban's 1st system, very effectually cover the shoulders and flanks of the counterguards; particularly in the 3rd system, where the ravelins also have substantial redoubts which, independently of the other advantages that they afford, have flanks so disposed as to see in reverse the breaches made in the faces of the counterguards, through the openings formed by the ditches. It is likewise to be observed that the body of the place closely defends the interior of the counterguards, which circumstance of course augments the difficulty and danger of the besieger, in erecting his works inside of them. But some of Vauban's secondary dispositions do not answer the purposes of his general arrangement, as the following explanation will show.

First, by constructing the ravelins with flanks, as he had done in his 1st system, Vauban left the openings between the tenailles and the flanks of the counterguards uncovered; so that the body of the place may be breached through those open-

ings, immediately after the re-entering places of arms have been crowned, as these works have no redoubts. Secondly, notwithstanding the smallness of the command which the tower-bastions have over the counterguards, yet their parapet and platform would be destroyed at an early period of the besieger's operations, on account of the considerable number of shot and shells which are thrown during a siege, as well as in consequence of the great precision with which artillery is at present served. Thirdly, Vauban's casemated batteries would also be destroyed by the besieger's counter-batteries at the gorge of the counterguards, or masked by the rubbish from the breaches made in the body of the place; and even supposing that a fire might be kept up in them, yet its effect would be materially impaired from the smoke to which the want of a proper circulation of air renders them liable;* so that the ditch of the body of the place having no effectual flanking defence, the garrison would be obliged to capitulate as soon as the besieger is in possession of the counterguards, and the breaches in the body of the place are practicable. In short,

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* It must however be acknowledged that according to an experiment made at Neufbrisack some years since, the inconvenience from the smoke, in Vauban's casemated batteries, is not so great as was previously apprehended.

Vauban's counterguards and ravelins being made empty in both his 2nd and 3rd systems, whilst the escarp of those of the 3rd system is supported by only a demi-revetment, with a berm along the top of the latter, the material advantages that the large dimensions of the exterior works in question would otherwise give, for the purpose of effectually retrenching them, are almost entirely lost.

129.—In order to elucidate this subject, it will at first be supposed that the terreplein of the counterguard to be retrenched fills the interior of this work, and that the escarp has a full revetment. Under such a supposition, the retrenchment may consist of two coupures drawn from the faces of the counterguard to its gorge, by which means they will cover the flanks and afford a cross fire upon the terreplein. These coupures should be connected by a covert-way, which, after following a direction parallel to the circular part of the gorge of the counterguard, is to be carried on to those parts of the coupures which adjoin the parapet of the faces, so as to form a kind of re-entering place of arms on each side. Or else, instead of this covert-way, a redoubt in the form of a Lunette with flanks may be made between the coupures, at the circular part of the gorge of the counterguard, being preceded by a ditch which meets the coupures. Whether a redoubt of this

description is constructed, or a covert-way, the retrenchment will with suitable communications afford a strong defence, and enable the besieged troops safely and conveniently to sally upon those of the besieger in the counterguard.*

130.—But an empty counterguard does evidently not admit of being retrenched as aforesaid; and indeed, unless the garrison should have the means (which is not probable) of throwing up within it works sufficiently elevated to secure the troops who occupy them from the plunging fire that the enemy would otherwise direct upon these troops from the terreplein of the counterguard, no other retrenchment can be usefully constructed except a redan, consisting of palisades, which, by covering the communication at the circular part of the gorge of the counterguard, will enable the troops who withstood the assault given to this work, to retire into the body

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* The two methods above explained of retrenching counterguards of the nature of those of Vauban, but supposing them to have a full revetment and their interior filled by the terreplein, are minutely described in Pl. 15. of the Author's Treatise on the general principles of Permanent Fortification, &c.; together with the communications from the body of the place to the retrenchment, and from the latter to the terreplein in front. The same plate also represents several other alterations suggested for the purpose of improving Vauban's 3rd system, and which are noticed in this Treatise.

of the place with greater security, through the communication in question.

131.—Even a full counterguard, but which like those in Vauban's 3rd system only has a demi-revetment, with a berm along its top, does not allow such a retrenchment to be made as would cover its flanks and materially facilitate the means of defending its terreplein; for, nothing can be done to retrench a counterguard of this kind to advantage, except constructing at the circular part of its gorge a redoubt similar to that previously described (129.) with a ditch in front. The reason is, that as the berm divides the height of the escarp, and enables the besieger to advance, by following it, to the rear of any retrenchment so placed as to have the flanks of the counterguard behind it, he can conveniently climb up the parapet of this work, in order to attack the retrenchment in reverse.

Empty ravelins, and ravelins which are full but have a demi-revetment, with a berm, clearly present as much inconvenience in retrenching them, as counterguards under the same circumstances.

132.—Whether a place is fortified according to Vauban's 2nd or 3rd system, the nature of the attacks to be carried on against it is much the same; observing however that the elements of the latter system being more complete and better

disposed than those of the former, the defence which it enables the garrison to make is longer. It should also be observed that, supposing the counterguards and ravelins to be full, and to have full revetments, the 3rd system is in point of strength so nearly adequate to the modern bastion system, that a theoretical examination of these two systems scarcely affords any means of ascertaining whether one of them is superior to the other. The most experienced engineers seem nevertheless to think that under the above supposition respecting the counterguards, ravelins, and the revetments of both these works, Vauban's 3rd system should enable the besieged troops to make a longer resistance, by availing themselves of the advantages which the counterguards give, when properly retrenched, to defend their interior. Indeed this system would be far above the Modern Bastion-System, if it were improved according to the several other alterations which have been suggested. (See note page 146.)

133.—In the following illustration of the process to be used in attacking places fortified with tower-bastions, this process will be applied to Vauban's 3rd system in particular, the attacks being directed against one ravelin and the two contiguous counterguards. It will be supposed that the ravelin and counterguards are full, and have their escarp supported by a full revetment;

so that the garrison had the means of constructing such coupures within them as cover their flanks, and securing the communication at the circular part of the gorge of each counterguard, either by a covert-way, or by a redoubt. (129.)

This being premised, the first operations of the besieger are to be the same as those explained with respect to inferior polygons fortified according to the modern bastion-system; and the calculation of the probable length of time necessary to carry on the attacks, until the besieger erects the cavaliers of trenches, also gives similar results; but as the ravelins have a smaller projection in Vauban's system than in the other, they will not so effectually impede the tracing and constructing of the cavaliers in question; therefore, these operations will require a shorter time, and be attended with less danger to the besieger, who will also have it in his power to embrace the three saliant places of arms at one time, with greater convenience; whilst the re-entering places of arms containing no redoubts, the crowning of the covert-way will be more safely, and more speedily, completed.* In short, the besieger will construct

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* It is also evident that Vauban's system affords greater facility to the besieger for storming the covert-way, than the modern bastion-system.

his counter-batteries and breaching batteries with the same degree of security and expedition.

It follows from the preceding observations that on the 30th day after breaking ground, the besieger may give the assault to the counter-guards, and form his lodgments on their terre-pleins; these lodgments being secured towards the coupures, by means of strong epaulments. It is to be remarked that, as the ravelins have flanks and therefore do not cover the openings between the profiles of the tenailles and the flanks of the counterguards (128.) the besieger should breach the curtain through the openings in question, as soon as he has crowned the re-entering places of arms. The batteries erected for this purpose will be ready for action in the beginning of the 26th day, and the breaches practicable in the course of the 27th day, or thereabouts.

134.—In the 31st night, the besieger's miners should be set to work for the purpose of establishing mines intended to breach the coupures of the counterguards, so that the whole retrenchment may be stormed on the 32nd day, at day-break.* A sap is then to be made in the parapet of each of those flanks of the counterguards which are

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* If instead of a covert-way, a redoubt should be constructed between the coupures (129.) mines are also to be established in order to breach it.

contiguous to the tenaille of the front of attack, this sap following the direction of the length of the flank, and being constructed according to the method described in paragraph 99; therefore, by carrying it on to the rear of the tenaille, it will enable the besieging troops to see this work in reverse.

135.—During the 33rd and 34th days, the besieger should construct batteries at the gorge of the counterguards, in order to breach those parts of the curtain of the front of attack, which are contiguous to the flanks of the tower-bastions; and the casemated batteries of these flanks being consequently masked by the rubbish from the breaches, will be useless to the garrison.* The besieger is also to gain the openings between the tenaille and the flanks of the counterguards, and to begin the passages leading from them to the opposite breaches, (133.) across the ditch of the body of the place; as well as those intended to lead from the gorge of the counterguards to the breaches which, as abovesaid, are to be made in the curtain, close to the flanks of the tower-bastions. All the passages in question require to be covered by double epaulments.

* Counter-batteries may also be erected at the gorge of the counterguards, so as to direct their fire against the flanks of the tower-bastions, and destroy their casemated batteries.

136.—If the besieged troops should persist in defending themselves, the passages across the ditch of the body of the place are to be continued; and as they will be completed in the 36th night for the latest, the besieger may assault the four breaches at one time on the next morning, at day-break.

137.—Vauban's 2nd system being inferior to the 3rd, does not in general circumstances allow any place fortified after it, to hold out beyond 30 or at most 32 days; it should be observed that such a longer resistance as may proceed from the spirited and successful exertions of the besieged troops in defending themselves within the counterguards, is not considered either in the above calculation, or in the preceding estimation of the duration of the siege that a place constructed according to the 3rd system is capable of sustaining; for, the length of that resistance can scarcely be fixed with any degree of precision.

138.—It was supposed in the preceding illustration of the method of attacking places fortified according to the tower-bastion systems, that the nature of the polygon admitted of the attacks being carried on against one ravelin and two counterguards; but if the polygon should be of a superior order, and the attacks in consequence directed against one counterguard and two ravelins (106.) the flanks of the tower-bastion which this

counterguard covers, will not be liable to the fire of any counter-batteries; so that in case the rubbish from the breaches made in the curtains, close to those flanks, (135.) should happen not to mask their casemated batteries effectually, the besieger will be obliged to construct mines in the gorge of the counterguard, these mines being disposed in such a manner that the rubbish produced by the explosion will be thrown opposite the flanks in question. The fire of the collateral tower-bastions will also bear upon the besieger in passing the ditch of the body of the place, and therefore require precautions which will retard this operation; it follows from the above circumstances, as well as from the obstinate defence which the besieged troops have the means of making within the counterguard, that, notwithstanding the advantages which the modern bastion-system in other respects has over Vauban's 3rd system (133.) yet these two systems are in point of strength very nearly adequate to each other, not only in inferior polygons, as was previously said, but likewise in those of a superior order.

139.—The following scheme was suggested for improving the 3rd system of Vauban, without deviating from his general purposes; and, by carrying it into execution, the place will be capable of holding out from 6 to 10 days longer, or perhaps

more, depending on the nature of the defence which the besieged troops will make in the counterguards. According to the scheme in question common bastions, connected by straight curtains, with tenailles in front, should be constructed instead of the tower-bastions and broken curtains which, in the original arrangement of the system, form the body of the place; these bastions and tenailles are to have the openings between them covered by the counterguards, and the bastions are to be retrenched. The ravelins and re-entering places of arms should be similar to those in the modern bastion-system, being supplied with redoubts constructed also in the same manner as the redoubts in that system; lastly, the counterguards should be made full, and full revetments substituted for the half-revetments with a berm, which Vauban employs; besides reducing to a suitable height those revetments of escarp which he improperly raises to the exterior crest of the parapet.

140.—Coehorn, a celebrated Dutch engineer contemporary to Vauban, is the inventor of three methods of fortifying towns, in which he particularly attended to the means of flanking and covering the works as effectually as possible; whilst those parts of the fortifications which are advantageously situated for the besieger's batteries, would not afford sufficient space for them. His object also was to enable the besieged troops to

carry on an active and obstinate defence; for which purpose he contrived such dispositions as would put it in their power to oppose the besieger, within the fortifications, with forces greater than his, and upon a larger front; besides securing the retreat of these troops, and exposing those of the besieger to the fire of the casemated batteries, crenelled galleries, covered caponiers, and coffers, which are employed in Coehorn's systems. This engineer likewise endeavoured to augment the difficulty for the enemy of making breaches, and disposed his covert-ways and dry ditches in such a manner that the besieger, being not able to dig the ground deeper than from 12 to 18 inches without finding water, may be obliged to convey to the spot the requisite materials for covering himself in his lodgments, as well as those necessary to construct the epaulments across the ditches in question; but this disposition, together with the combined use that Coehorn makes of wet and dry ditches, and which forms an essential part of his systems, evidently requires that the fortifications should be erected in aquatic ground, as he supposes them to be.

141.—The considerable degree of ingenuity and professional knowledge, which Coehorn has displayed in his systems, highly deserves to be noticed by every engineer; but it is to be regretted that even the productions of the most eminent mas-

ters of the art of fortifying leave a vast field for improvements. In Coehorn's 1st system, for instance, the flanked angles of the bastions have a small opening, whatever the polygon may be, and therefore the faces are uniformly subject to enfilade, as well as those of the ravelins and other principal works; whilst the parallel directions of such faces of all these works as are immediately in front of one another, afford great facility to the besieger for determining the situations where his enfilading batteries are to be erected, since it is only necessary for him to take the prolongation of one of the faces in question, and to know the distances from it to the others, which distances the construction of the system gives with precision. Besides, the artillery of the capital works is the only one which has a direct action upon the attacks, and, as these works project but little towards the country, their cross fire in front of the saliants is not very effectual. It should also be observed that, on account of the counterguards, the saliant places of arms opposite the flanked angles of the bastions advance further into the country than they would otherwise do; and the projection of the capital ravelins being small, these works scarcely have any action upon the crowning of the saliant places of arms above alluded to; the front of attack may consequently in all circumstances consist of one

ravelin and the two collateral bastions;* and as the three saliants of this front are nearly in a straight line, with the re-entering places of arms at a short distance from them, the whole covert-way can be crowned at one time; only, this crowning must embrace five saliant and four re-entering places of arms, in order that every part of the front of attack may be enfiladed, or seen in reverse.

Independently of the above defects in Coehorn's 1st system, the openings between the ravelins and the profiles of the counterguards allow the bastions to be breached through them, from the crowning of the covert-way; whilst the redoubts, crenelled galleries, caponiers, and coffers, having no sufficient strength to resist the effect of the besieger's artillery, he will render them unserviceable before he has any thing to apprehend from them; consequently, the re-entering places of arms, together with their redoubts and coffers, will not effectually protect the covert-way. It is likewise to be remarked that, on account of the insufficient thickness of the walls which form the caponiers constructed in the direction of the

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* It is almost needless to explain that in the above description of the nature of the front of attack in Coehorn's 1st system, the lower and the capital ravelins are considered as forming only one work, as well as the lower and the capital bastions, on each side.

capitals of the bastions and ravelins, they are liable to be destroyed not only by the shells falling upon the caponiers, but also by the explosion of those which may happen to fall near them; and, as the bottom of the caponiers is sunk 3 feet below the level of the water, the water will come in, so that these works will not answer the purposes for which they are intended. Besides, the communications with the exterior works, across the wet ditches employed in the system, are very inconvenient, and the retreat of the troops from these works very precarious.

Another material defect, in Coehorn's 1st system, consists in the improper situation of the orillons constructed at the shoulders of the lower bastions; for, they evidently mask the fire which the garrison would otherwise be able to keep up from the flanks of the collateral bastions, in order to protect the dry ditch between the faces of the lower and the capital bastions contiguous to the orillons; therefore this ditch remains without any flanking defence after the besieger has destroyed those casemated batteries under the orillons, which are intended to flank it, and also battered down the walls near them behind which artillery is to be placed for the same purpose.

142.—Coehorn rectified in his 2nd system several of the defects of the 1st; in that system the situation of the orillons allows the fire of the

flanks of the bastions to defend the dry ditch in front of the faces; whilst, independently of the convenient and safe communication which this ditch affords all around the body of the place, as well as with the ravelins and *lower rampart*, its breadth enables large bodies of troops, and even cavalry, to attack the enemy within it.* Besides, the ravelins and lower rampart being connected, leave no openings through which the body of the place can be seen; and they also are effectually covered by the *2nd counterscarp*;† lastly, Coehorns's 2nd system requires a smaller quantity of masonry than the 1st; but, similarly to the latter, it is much exposed to the ricochet fire. In order to improve it still more than Coehorn has done, all the galleries, caponiers, &c. should be made bomb-proof, with their lower part raised above the level of the water; whilst the re-entering places of arms should contain substantial redoubts, capable of resisting a sudden attack; the re-

* In order that troops of any kind may freely communicate all around the body of the place through the dry ditch in front, Coehorn does not in his 2nd system employ the caponiers which, in the 1st system, are made in the direction of the capitals of the bastions.

† Coehorn's intention was that pontoons, carrying a parapet capable of resisting musquet shot, should be used in the wet ditch at the gorge of the 2nd counterscarp, for the purpose of seeing in reverse such lodgments as the besieger might construct in this work, after penetrating into it.

doubts at the saliant and the re-entering parts of the 2nd counterscarp also require to be strongly constructed, and to have a wet ditch in their front; in short, the projection of the ravelins should be augmented by means of making the angles formed by their faces 60°, instead of 70° which Coehorn allows them.

143.—With respect to Coehorn's 3rd system, all engineers coincide in their opinion that it is inferior to the 1st, and consequently, to the 2nd system; therefore no further notice of it will be taken in this Treatise.

144.—Of the three systems which Coehorn contrived, only the 1st ever was executed; and, in order that any Reader unacquainted with the disposition of the attacks suitable for a place forfied after it, may more clearly understand the explanation about to be given on this subject, the following remarks will be premised.

First. Coehorn's 1st system requires that the besieger's artillery should be more numerous than for the attack of a place constructed according to the modern bastion-system, or to any of Vauban's systems;* but the besieged troops

* In attacking a place fortified according to Coehorn's 1st system, the 1st batteries require about 120 pieces of ordnance, 50 of them consisting of howitzers and mortars.

are also to be supplied with a greater number of pieces of ordnance, as independently of those placed in such other parts of the fortifications as admit of them, some should be established in the dry ditches; the latter being so directed that the shot, &c. after passing over the parapet of the works in front, will bear upon the enemy's trenches; indeed, the besieged troops have no other means of enfilading with their artillery the trenches which form the crowning of the covert-way.

Secondly, the same system also requires that the 1st parallel, which other systems allow to be placed at the distance of 600 yards from the most advanced saliants of the covert way (23.) should not be further than that distance from the saliants of the lower bastions and ravelins, or even from the capital works behind them; the reason is that by being nearer to these works, which it is materially important for the besieger to enfilade, his 1st batteries will be able to keep up a more effectual ricochet fire against them; whilst the requisite length of the 1st parallel will likewise be smaller.

Thirdly, the besieger should very accurately determine the prolongations of all the faces to be enfiladed, and erect ricochet batteries not only against the works belonging to the front of attack, but also against the collateral ravelins; such of these batteries as are intended to enfilade the

terrepleins of the capital works, should consist of guns; and those directed against the dry ditches, covert-way, and the coffers in front of the re-entering places of arms, are to contain howitzers, or mortars mounted upon carriages which allow them to be used for ricochet firing.

Fourthly, it was said in the preceding investigation of the defects of Coehorn's 1st system (141.) that the besieger would render unserviceable the coffers, redoubts, caponiers, and crenelled galleries constructed in that system, before having any thing to fear from them; and the truth of this assertion can scarcely be doubted when, independently of the numerous batteries of all kinds which according to the nature of the attacks the besieger is successively to employ at different distances from the works of the place, the present highly improved state of the artillery is considered. The casemated batteries which defend the ditches of the bastions will for the same reason be also destroyed; whilst the terrepleins of the flanks of these works will become untenable, as well as those of the orillons.

Fifthly, the arrangement of the system in question not allowing the fire of the place to impede the besieger in his approach more effectually than if the place should be fortified according to Vauban's 1st system, both systems require the same time, or thereabouts, in order that the besieger

may gain the spot for the cavaliers of trenches; but, as the terrepleins of the counterguards and lower ravelins do not afford room for artillery, the cavaliers will be constructed with greater convenience, and the re-entering places of arms sooner crowned.

Sixthly, as Coehorn's counterguards and lower works consist entirely of earth, they cannot be breached by guns but with great difficulty; and it still remains to be ascertained whether loaded shells, fired in a horizontal direction, may by exploding form in two or three days such openings through them, as will afford a convenient passage for the shot of the batteries directed against the works which they cover;* admitting that, conformably to the prevailing opinion, loaded shells

* Mortars mounted upon suitable carriages may of course serve like howitzers, in making the openings alluded to in the above paragraph; observing that such mortars and howitzers as are used for that purpose, should have charges much smaller than those allowed to them in different circumstances; whilst a greater quantity of powder ought to be put into the shells, than is necessary to make them burst; all the howitzers or mortars of the same battery should also be fired together.

Experiments carefully made, in order to ascertain more positively than has hereto been done the effect of mortars and howitzers employed as aforesaid, as well as the charges most suitable for them and the shells, would answer various highly important objects.

will accomplish this purpose, and also, that the garrison will not be able to fill the openings in the night with earth and fascines, the resistance of the place will be very short; but under different circumstances, it will be longer, its precise duration depending upon whether mines may be used or not, in order to effect the openings in question, and thus abridge some of the besieger's operations.

Lastly, in attacking a place fortified according to the system under consideration, a 4th parallel should be made; so that by bearing close upon the enemy, it may allow the troops posted within it, &c. to protect effectually the besieger's numerous batteries, which occupy a considerable portion of the crowning of the covert-way; whilst on account of the small distance from the parallel to the batteries, the materials and other supplies requisite for the latter, will be conveniently and expeditiously conveyed from the former.

145.—The 4th parallel and the cavaliers of trenches being completed in the course of the 14th night, the besieger should advance the next day towards the five saliant places of arms (141.) for the purpose of crowning them. He should also commence the approaches towards the four re-entering places of arms.

146.—On the 15th day, the batteries to be erected at the three saliants of the covert-way of the front of attack should be begun, and the

branches of this work crowned, together with the faces of the four re-entering places of arms.

147.—During the 16th and 17th days, the besieging troops are to complete every part of the crowning of the covert-way which may still remain unfinished; they should also construct such batteries along the branches of the covert-way and the faces of the re-entering places of arms, as are requisite in order to oppose their fire to that of the artillery of the place, raze portions of those works which Coehorn entirely makes of earth, and breach the capital works through the openings thus formed; besides destroying the redoubts, crenelled galleries, caponiers, &c. which are employed in this Engineer's system.

148.—The various objects which the aforesaid batteries are to answer, of course require that their artillery should consist of pieces of ordnance of different kinds; fifty guns at least will be requisite, and sixty mortars, or large howitzers. The distribution of the batteries in question, and their particular purposes (besides serving as counter batteries) are now to be explained, it being supposed that loaded shells, fired in a horizontal direction, may be effectually used to raze Coehorn's works of earth. It is to be observed that the arrangement of the artillery at first placed in the batteries should be subsequently changed, according to circumstances; for instance, after

using mortars and howitzers in order to make openings through the rampart of the lower works, so as to see the capital works and breach them, a suitable number of guns should be substituted, to effect the breaches.

149.—The batteries at the saliants of the covert-way have for their object to destroy the opposite traverses of the re-entering places of arms, and afterwards the gorges of the redoubts of these works; as well as to throw shells into the dry ditches in front of the capital bastions and ravelins. These shells should be chiefly directed to those parts of the ditches where the caponiers are situated, as, besides the injury which they may do to the caponiers, they will also impair the effect of the artillery that the garrison will undoubtedly place near them for the purpose of enfilading the besieger's works on the crest of the glacis (145.)

150.—Independently of the batteries erected at the saliant of the covert-way opposite the lower ravelin of the front of attack, others should be constructed alongside of them, in order to raze the faces of the lower bastions through the ditch of this ravelin, and then breach those of the capital bastions; a fire may also be kept up from these batteries against the traverses and redoubts of the re-entering places of arms contiguous to the ravelin, supposing that the effect pro-

duced by the batteries at the saliant has not been sufficient to oblige the besieged troops to retire entirely from the re-entering places of arms.

151.—Batteries are likewise to be established on both sides of the lower ravelin of the front of attack, opposite the flanked angle, so as to raze the faces, render the caponier which they cover entirely unserviceable, and destroy the coffers constructed at the gorge of this ravelin, across the dry ditch.* The faces of the lower ravelin should also be razed, and those of the capital ravelin breached, by means of batteries, firing through the ditches in front of the interior faces of the counterguards;† and as the breaches allow these batteries to see the redoubt at the gorge of the capital ravelin, they are to destroy it.

152.—The interior faces of the counterguards should be preserved entire, but batteries are to be erected immediately in front of the exterior faces, so that after razing them they may direct their fire against the opposite treble flanks of the

* The batteries opposite the flanked angle of the lower ravelin also see the banquettes of this work, through the openings which they have made in the faces.

† By the interior faces of the counterguards are meant those contiguous to the ravelin of the front of attack; the faces on the other side are of course the exterior ones.

bastions, and throw these flanks down one upon the other; besides breaching the orillons on the same side, in consequence of which the rubbish produced by the breaches will stop the communication through the aqueducts placed under the faces of the tenaille. The above batteries will also be able to enfilade the dry ditches between the capital and the lower bastions, and may therefore be employed in destroying such parts of the orillons as flank these ditches; as well as the walls behind the bridges placed close to the shoulders of the capital bastions.*

153.—Besides the batteries which fire against the bastions through the ditch of the ravelin, others should be constructed within the re-entering places of arms, near the gorge, for the purpose of razing the faces of the lower bastions, through the openings between the ravelins and the profiles of the counterguards, and afterwards breaching the brisures of the curtain, together with the orillons;† so that the latter being

* After razing the exterior faces of the counterguards, the batteries used for this operation will see the banquettes of the interior faces.

† Bousmard and other Engineers employ for breaching the brisures of the curtain, &c. batteries erected on the glacis, along the faces of the re-entering places of arms, instead of being placed within these works; and the command of the place over them is of course smaller in the former situation,

battered from three different situations, will scarcely be able to resist the powerful effect of the artillery employed to destroy them.

154.—It is probable that the fire of such of the besieger's ricochet batteries as enfilade the dry ditches between the lower and the capital bastions, will partly bear, (in an oblique direction) upon the galleries placed under the terrepleins of the former bastions; in such a manner that before the covert-way is crowned, these galleries will be materially injured, if not rendered entirely unserviceable; but, supposing that the besieger should find it necessary to direct a greater quantity of fire against them, this may be conveniently done by means of a small number of pieces of ordnance placed on the glacis in front of the ravelins and re-entering places of arms.

155.—On the 17th day, whilst the besieger is engaged in constructing his batteries, he should also make four coupures, one on each side of the re-entering places of arms of the front of attack, close to them, so as to descend from the glacis

than in the latter; the batteries may also be constructed at an earlier time, but besides being more distant from the objects that they are intended to breach, they have the inconvenience of requiring very oblique embrasures; and it may also happen that their fire will be impeded by the rubbish from the traverses and redoubts of the re-entering places of arms.

upon the terreplein of the covert-way, and prolong the coupures across the latter. The rubbish from the traverses of the re-entering places of arms will secure in flank the coupures in question, but they should be covered at top by means of blindes (note, page 106.)

156.—After carrying on the coupures as far as the counterscarp of the counterguards and lower ravelin, the besieger is to commence the requisite bridges and epaulments for passing the wet ditches in front of both the abovesaid works. The two bridges leading to the ravelin should be directed towards such extremities of the openings made in its faces, by the batteries erected opposite the flanked angle (152,) as are nearest to the gorge; and, the interior faces of the counterguards, to which the other bridges lead, having been preserved entire (153) will cover the besieger while he is constructing these bridges.

157.—The batteries will be ready for action in the morning of the 18th day, and should from that time keep up an uninterrupted fire, so as to accomplish as expeditiously as possible the various purposes for which they are intended.

158.—The bridges and their epaulments being terminated on the 19th day, the besieger should immediately cross the ditch of the lower ravelin, and begin a sap in that part of the rampart of each face of the latter which the batteries have

not razed, so as to gain the openings made in the faces through the ditches of the counterguards (152.), and from thence the breaches effected, through the same openings, in the faces of the capital ravelin. This ravelin is to be assaulted the next day,* and a sap opened in the rampart of the interior face of each counterguard; which sap being carried on towards the ravelin, will enable the besieger to advance to the extremity of the face, for the purpose of constructing a bridge across the wet ditch in front of the opposite bastion.†

159.—The bridges which, as abovesaid, are to lead from the extremities of the interior faces of the counterguards to the bastions, should be commenced on the 21st day, and batteries established upon the terreplein of the capital ravelin, in order to complete the destruction of the orillons and the brisures of the curtain; the bridges will be terminated in the course of the 23rd day; so that the faces and flanks of the capital bastions being breached by that time, as well as the brisures of the curtain, the assault may be given the following day.

* It may happen that the breaches in the capital ravelin will not be practicable before the 21st day, in which case the assault, and therefore the besieger's subsequent operations, must of course be proportionably retarded; so that the place will hold out one day longer.

† The saps carried on in the rampart of the lower ravelin,

160.—Under the supposition that loaded shells, fired in a horizontal direction, may not answer the purpose of razing the works of earth of Coehorn, the besieger will perhaps be able to employ mines for making openings in the ramparts of the lower ravelin and the counterguards, so as to breach the capital ravelin, the flanks of the bastions and the orillons, through those openings; after which, he should give the assault to the capital ravelin, and construct batteries within it for the purpose of entirely destroying the orillons. This being done, the besieger is to pass the ditch opposite the orillons, and to gain the faces of the capital bastions, as well as the brisures of the curtain, in order to breach both these parts of the body of the place by means of mines, and proceed to the assault. This kind of attack will probably allow the garrison to hold out 36 days.

161.—But if neither loaded shells nor mines could be used to raze the lower ravelin and the counterguards, the besieger will be obliged to attack both these works in the usual manner, and to construct within them the requisite batteries to breach the capital ravelin, the flanks of the bastions and the orillons. The capital ravelin being

as well as in that of the interior faces of the counterguards, should have the form of *crémailléres*, similarly to the saps e' represented in Pl 4. Fig. 21.

taken, other batteries should be established there, also directed against the orillons; and the remainder of the operations is to be carried on conformably to the process explained in the preceding paragraph.

An attack of the nature of that just described essentially requires that the besieger should enfilade, by means of strong ricochet batteries, the dry ditches in front of the capital ravelin and capital bastions, but particularly those before the latter; and also, that he should erect these batteries in situations gradually nearer to the ditches, as he advances. From 40 days at least, to 45 days, will be requisite to take the place.

162.—Cochorn's 2nd system being superior to the 1st, it is calculated that the defence which it enables the besieged troops to make, may last between 40 and 60 days, according to the nature of the process employed for attacking the place.

163.—The advantages of the Modern bastion System over Vauban's 1st system, of which it is an improvement, have been illustrated (126.); but notwithstanding these advantages, it still retains various material defects, the nature of which some readers might not have clearly understood, had they been investigated in an earlier part of this treatise; and that investigation was consequently postponed. The principal defects in question are such as follow:

First, with the exception of the polygons of a very superior order, and of such portions of a fortress as may consist of several fronts disposed either in a straight line or on a concave curve (106. and 123.) the body of the place is not better secured from ricochet fire, than any other part of the fortification; and no portion of the ground where the attacks are to be carried on is sufficiently re-entering to render them liable to any very effectual fire, in flank and in reverse; the sallies are therefore feebly protected, and the besieger may at one time crown all the saliants of the front of attack, without being much exposed in consequence of this operation.

Secondly, the modern bastion system is not less deficient than that of Vauban, in places of security for the artillery and troops; on which account, no batteries can be preserved entire for the most important period of the siege; whilst, independently of being exposed to the destructive effect of the ricochet fire kept up by the besieger from the commencement of the attack, the troops are during the near defence subject to such a vertical fire from his batteries, as must render the terrepleins almost untenable, and consequently weaken the defence to a considerable degree.

Thirdly, although the larger dimensions of the re-entering places of arms, besides their substantial redoubts, much improves the defence of

the covert-way, yet this work can be stormed; and further improvements in its disposition are still requisite, to enable the garrison to defend it with great obstinacy. It should also be observed that the besieger may dislodge the troops posted in the redoubts of the re-entering places of arms, without being obliged to breach the redoubts and storm them. (98.)

Fourthly the besieger has it in his power to breach the bastions through the ditch of the ravelin, even before he has taken this work; and, after taking it, he can also breach them through the ditch of the redoubt; whilst the openings between the profiles of the tenaille and the flanks of the bastions allow the curtain to be breached through them, from the terrepleins of the redoubts in the re-entering places of arms.

Fifthly, the ditches of the ravelin and its redoubt are not so effectually flanked as they should be; and, on account of the relief of the tenaille, a portion of the ditch in front is not defended.

Lastly, the modern bastion system presents the same inconveniences as Vauban's 1st system, with respect to the construction of the retrenchments in the bastions, the considerable quantity of timber requisite during the siege, &c.

164.—Several distinguished engineers have suggested schemes for the purpose of augmenting the duration of the defence which places con-

structed according to the modern bastion system are capable of making;* and others have of late years published new methods of fortifying, which may in some measure be considered as original systems; but notwithstanding the great ingenuity and professional knowledge generally displayed by the engineers in question, yet they have not resolved the very difficult problem of producing a system of fortification to which no well-founded objections can be made; advantages which they have gained on one side are coupled with inconveniences on the other, and a long time may still elapse before perfection in the art of fortifying is attained.

165.—By considering the nature of the advantages and defects of such methods of fortifying towns as were hereto used, it appears that the arrangement of any system of fortification intended for this object should be regulated according to the following general principles: namely, the

* Pl. 20. Fig. 76. of the Author's Treatise on the general principles of Permanent Fortification, &c. represents one of the schemes suggested for the purpose of strengthening the modern bastion-system, and the execution of which would augment the probable duration of the siege by 8 or 10 days. An improvement of the scheme in question is also represented in the same Plate, which, without requiring any great additional expence, would in polygons of a superior order enable the garrison to hold out 15 days beyond the usual time.

body of the place should be concealed from the besieger's view until he has taken the exterior works; and whenever it is liable to the effect of ricochet fire, it should be defiled as well as can be done. There ought to be covered batteries for the particular purpose of annoying the besieger during the near defence, and which are so situated as to bear in flank and in reverse upon his lodgments on the crest of the glacis; these batteries being only exposed to the fire of those which he may establish upon the spot that the other batteries are intended to defend. All parts of the system also require places where the troops appointed for their defence may remain with safety, when they are not actually engaged; and if it should be thought that any of those parts are not sufficiently protected by the fire kept up from behind the parapets of the works which are to flank them, this deficiency is to be made up by means of crenelled galleries secured from the enemy's batteries. Besides, whatever retrenchments may belong to the system, should be so contrived as to oblige the besieger to attack them regularly; or, if this condition cannot be strictly attended to, their disposition should at least be such as to render any other kind of attack very destructive to him. It is likewise required that the arrangement of the covert-ways should facilitate the means of making sallies, as well as those of effectually protecting the troops who make them, and executing all the ne-

cessary manœuvres for an active defence; whilst the relief and command of the works are to be so regulated that every part of the fortifications being properly covered, the besieged troops may nevertheless keep up such a fire of artillery and musquetry as may be requisite to defend the inside of the works, and the exterior ground. In short, the system should admit of defensive mines so planned as to prevent the besieger from constructing any counterbatteries on the glacis, or any breaching batteries, before he has executed the long and toilsome operations of a subterraneous war; or, which will oblige him to substitute offensive mines for these batteries.

166.—The general principles about to be investigated in the 2nd part of this treatise, on the subject of the defence of places, will be applied to three successive periods of the siege, similarly to the arrangement of the explanation given in the 1st part, respecting the process to be used for carrying on the attacks. All the dispositions which the garrison should make, before the besieger breaks ground, will be included in the 1st period, and the second is to contain the operations of the besieged troops, from the opening of the trenches to the establishing of the 3rd parallel. The remainder of the operations of these troops until the place is surrendered, will form that part of the investigation which relates to the 3rd period.

PART II.

ON THE DEFENCE OF PLACES.

CHAPTER VII.

A general investigation of the dispositions to be made, in order to put a Fortress in a state of defence: On the construction of Barbet-Batteries, temporary covered-Batteries, Retrenchments, Tambours, horizontal, inclined and double blindages, Traverses, Parados, temporary Powder-Magazines, &c. Flèches, and Counter-approaches: On the proper method of palisading the Covert-way.

167.—WHAT is meant by putting a fortress in a state of defence consists in supplying it with the necessary garrison, as well as with the requisite quantity of artillery, grenades, blunderbusses, rampart-fusils, common musquets, pikes, and other weapons. A sufficient quantity of ammunition, for the longest siege which the fortress is capable of sustaining, should also be conveyed to it, and a proper stock of provisions laid in, according to the strength of the garrison and the number of inhabitants who are to remain in the place. Timber, likewise, is to be collected for

palisades, *blindages,** tambours, platforms, temporary powder-magazines, bridges, galleries, single barriers, double barriers, and for other uses; besides fuel, tools, gabions, saucissons, fascines, hurdles, piquets, materials for combustible preparations, medicines, and various other kinds of supplies.

Independently of the abovesaid dispositions, the fortifications, store-houses, sluices, wells, cisterns, hospitals, and other establishments, should be put in the best possible order; the slopes of the parapets should be repaired, the banquettes formed, the old barbet-batteries rendered fit for immediate use, and such new ones constructed as may be necessary; the casemates and galleries are also to be cleaned and aired, and the posterns opened; whilst suitable buildings should be secured by means of blindages (182.) so as to place there troops, ammunition, or provisions. The same precaution is to be taken in respect to those sluices, wells, and cisterns, &c. which require it; in short, the requisite communications are to be established, and the covert-way palisaded; the passages round the traverses of the saliant and the re-entering places of arms being supplied with single barriers, and the sally-ports,

* The general purpose of a blindage is to form a covering which secures the troops, &c. placed under it from the vertical fire of the enemy.

or other wide communications, with double barriers.*

Besides, as the ground in front of the place should afford no advantageous cover to the besieger, the trees, brushwood, furze, hedges, &c., within 1,000 or 1,200 yards round the town, should be cut down, and the ditches filled up. The walls of inclosure are also to be destroyed, and the houses demolished, unless they are so situated as not likely to facilitate the operations of the enemy, or impede those of the garrison; whilst, if time and other circumstances allow it, such temporary works are to be thrown up, as will strengthen some weak fronts, and oblige the besieger to begin his operations further from the place. Lastly, arrangements should be made in order to establish as many baking houses, private hospitals, &c. as may be necessary.

Previous to giving any account of the operations of the garrison, at each particular period

* Whenever a fortress is to be put in a state of defence, a body of artificers should be immediately established, chiefly composed of carpenters and smiths, who are to work without any intermission at the palisades and barriers of the covert-way; as well as at the blindages of every description, which may be necessary. They should also prepare the timber for the tambours, platforms, bridges, temporary powder-magazines, &c. so that they may afterwards be speedily constructed.

of the siege, the following methods of constructing barbet-batteries, temporary covered-batteries, retrenchments, tambours, blindages, traverses, parados, temporary powder-magazines, flêches and counter-approaches, will be explained; as well as the manner in which the covert-way should be palisaded.

168.—The barbet-batteries *c* (*pl.* 6, *fig.* 32 *and* 33) are usually placed at the saliants of the works which contain them; and, as the guns are to fire over the parapet, the terrepleins of these batteries should of course be raised above those of the works, in a proportion determined by the elevation of the guns when mounted upon their carriages*. In regulating the length of a barbet-battery, about 15 feet are generally allowed for the distance between each two guns, the breadth of the terreplein being from 20 to 24 feet. One or two ramps *a* 12 feet wide, with a slope equal to six times the height of the terreplein of the battery over that of the principal work, serve to

* The *travelling carriage* raises the gun 3 feet 11 inches, and the *garrison carriage* 2 feet 9 inches: the former admits of the terreplein of the barbet-battery being 3 feet 6 inches below the crest of the parapet, and the latter 2 feet 4 inches. Guns placed on *traversing platforms* can be fired over the parapet, without standing on a terreplein purposely raised; but these platforms are chiefly used against shipping.

communicate from one terreplein to the other; the disposition of these ramps allowing the banquettes *b*, contiguous to them, to be used.

169.—It has been suggested that in order to secure a portion of the artillery of a besieged place, it should be lodged in bomb-proof casemates of timber, whilst firing; and *pl.* 7, (*fig.* 34, 35, 36, 37, 38.) shows the arrangement of a casemate of this description which the French Engineer Carnot caused to be made at St. Omer, some years since, for the purpose of ascertaining the best method of constructing them. This casemate was established upon the terreplein, and contained two 24 pounders mounted upon ship-carriages; its dimensions being 20 feet in length, 23 feet in breadth, and 8 feet in height. It was covered at top by beams 1 foot square, which were placed close to each other and had earth laid over them to the height of 6 feet. Other beams, also 1 foot square, and fixed in an upright position, supported the former along the sides of the casemate; as well as in the middle, between the two platforms. The embrasures were both oblique, and pierced through the whole thickness of the parapet; being covered at top by beams and earth like the casemate, and the cheeks having a revetment of thick planks nailed to uprights; the embrasures were 2 feet wide at the neck, and the same dimension was allowed for their height; whilst, at the mouth, the dis-

tance of each cheek from the line of fire or central line of the embrasure, was equal to 1-fourth of the length of this line. Both embrasures had sliding shutters*.

In the course of the experiment, neither the casemate, nor the embrasures, were materially injnred by the explosion, as only a very small number of the planks used for reveting the cheeks gave way, besides the soles being slightly affected near the sills; and, although a considerable portion of the smoke was repelled into the casemate, yet it went off in two or three minutes, and did not incommode the artillery-men who were working the guns; it was even observed that the return of the smoke into the casemate could be prevented by closing the shutters of the embrasures, immediately after the explosion.

Notwithstanding the favourable results which Carnot's experiment afforded in several respects, yet his method of constructing casemates of tim-

* In order that casemates of timber constructed according to Carnot's method may be made with greater convenience and expedition, it was proposed, subsequently to his experiment, to substitute trunks of trees 12 inches in diameter, with the bark on, for the squared beams which he employed; and also to revet the cheeks of the embrasures with strong piles, so as to remove every apprehension of the cheeks being damaged by the firing of the guns. (*See pl. 7, fig. 39.*)

ber for artillery is not to be followed, as the great width which the embrasures require, facilitates the means to the besieger of firing into them, and also has the inconvenience of weakening the parapet between the embrasures, so that it is liable to be destroyed by the fire of any heavy guns bearing upon it in an oblique direction; whilst on account of the casemates being placed on the terre-plein, they are exposed to be struck by the shot proceeding from the besieger's ricochet batteries.

170.—Indeed the defect which Carnot's casemates have of requiring very wide embrasures, might be to some degree diminished by means of making the latter similar to the embrasure A (*Fig.* 40.) which allows the muzzle of the gun fired through it to be nearer to the exterior line *a b* of the parapet; so that the embrasure may be made narrower; but such a rectification could evidently not be carried to any great length, and besides, the casemates would be equally liable to be struck by the shot from the ricochet-batteries of the besieger.

171.—The following process, for constructing casemates of timber intended to secure artillery, is far preferable to the method of Carnot. According to the process in question, the casemates A (*Fig.* 41 *and* 42.) should be made in the parapet, as this situation will secure them from ricochet fire; they are to be covered at top in the same

manner as Carnot's casemates, but, for each gun, the front is to consist of beams *b* (Fig. 41.) 15 ft. long, and 1 foot square, or rather more, forming an epaulment about 4 ft. 6in. thick through which the opening *c* is to be cut, so that the muzzle of the gun may project beyond this epaulment. The neck *d* of the embrasure *d e*, which is pierced through the exterior slope of the parapet, should as well as its mouth *e* not be larger than is necessary to allow the gun to be fired in such directions as may be requisite, in consequence of the particular purposes which the fire from the casemate is intended to answer.

If instead of a gun, an howitzer should be placed in the casemate, or a mortar mounted on a carriage which allows it to be used as an howitzer, the embrasure must of course be larger than for a gun, and its dimensions are therefore to be regulated accordingly.

172.—The use of casemates of timber, in order to secure the artillery of a besieged place, is to be recommended whenever the garrison has the means of constructing them; and under different circumstances, traverses and parados should be substituted for these casemates.

173.—Bastions may be more or less effectually retrenched, according as they are full or empty, wide or narrow. The time, as well as the quantity of materials and number of workmen, that

the besieged troops may have in their power to employ for constructing the retrenchments, should likewise be considered.

It is scarcely possible to erect any effectual retrenchment within an empty bastion;* on which account the besieged troops sometimes only construct a coupure in the direction *a b* (*Fig.* 45.) that is, from one angle of the flank to the other; or else, they pierce crenels through the walls of the nearest houses *c*, and make coupures *d* across the streets or other intervals which separate them; besides tambours *e* in front of these coupures, the height of the former being such as to allow the fire of the latter to pass over them; passages *f* are established, for the purpose of communication. The crenelled houses *c* may likewise be connected with the adjoining curtains by means of coupures *g* crossing their rampart, and which should be defiled from the fire that the besieger would otherwise direct upon their terrepleins, from that of the bastion.

174.—Full bastions admit of being more effectually retrenched than the preceding; and, when they are small, their retrenchments commonly have the same disposition as either one or the other of the retrenchments *a b c* and *d e f g h*

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* See the Author's Treatise on the General Principles of Permanent Fortification, &c.; paragraphs 98 and 99.

represented by Fig. 46 and 47. But if the bastions should be very large, a front of fortification composed of two half-bastions and a curtain, may be constructed on the line *ab* (Fig. 48.) which connects those parts of their faces where the prolongation of the exterior line of the parapet of the ravelin on each side, meets them. Or else, a work consisting of two faces *c d* and *e f*, connected by a curtain *d e*, may be thrown up, with a redan *g h i* in front, from which it is separated by a ditch *k*; the communication between this ditch and such a part of the terreplein of the bastion as the work *c d e f* covers, consists of a postern *l*, and steps or ramps *m* serve to gain the interior of the redan, from the ditch; whilst, in order to communicate with the other part of the terreplein, steps or ramps *n* are made, leading to it from the ditch of the redan; besides bridges of timber *o* which the besieged troops lay across the ditch of the work *c d e f*, and should preserve in this situation as long as can be done without danger.*

It should be observed that in order to have the means of affording a flanking defence to the

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* In order to secure for the longest possible time the communication through the bridges *o* and other similar bridges, they may be covered by a kind of traverse *p* consisting of gabions, and which is so placed as to allow a free passage round it.

ditches of the redoubts which the ravelins contain in the modern bastion system, as well as to the terrepleins of the ravelins, a clear space *q r*, 54ft. long at least, is to be left between the retrenchments and the shoulders of the bastions, whatever the dimensions of these works may be.

175.—The most effectual method of retrenching a wide bastion, provided the besieged troops have the necessary means to employ it, is to construct, besides the works on the terreplein, a front of fortification A (*Fig.* 48.) sufficiently retired to stand in the rear of any breach that the besieger may make, not only in the faces of the retrenched bastion, but also (and particularly if the ditch in front of the bastion is dry) in the adjoining curtains *s, t*, through the openings between the flanks of the bastion and the tenailles. This front must of course be placed behind the gorge of the bastion, and terminated at both ends upon the curtains, beyond the points where the profiles of the tenailles, if prolonged, would meet them. A postern *u* forms the communication from the place to the ditch of the retrenchment, and this ditch is traversed by a caponier *v* leading to steps *w* which are made at the re-entering angle of the counterscarp, for the purpose of gaining the terreplein of the bastion.

It must be admitted that the above method of retrenching wide bastions requires a great quanti-

ty of timber, besides such a number of workmen as the garrison may sometimes not be able conveniently to afford; therefore, if any fortress should happen only to have one or two fronts liable to be attacked, the retrenchments A might be permanently constructed, and those on the terrepleins made during the siege.

176.—No retrenchment constructed on the terreplein of a bastion should have a greater command over it than 3ft. or 3ft. 6in.; and from 15 to 18ft. are usually allowed for the thickness of the parapet, the slope of the escarp being regulated according to the relief of the retrenchment; the breadth and depth given to the ditch chiefly depend on the quantity of earth necessary to construct the retrenchment, and, supposing the latter to be made during the siege, both the escarp and counterscarp are supported by fascines *a* and *b* (*Fig.* 49.); or else, fascines are only employed for supporting the escarp, whilst the earth on the side of the counterscarp is retained by means of posts *c* (*Fig.* 50.) about 10in. square, besides planks *d* 2in. thick, which are placed over each other, between the posts and the ground. Palisades and fraises are used to render the retrenchment more secure.

177.—Supposing a ravelin to be full, and supplied with a permanent redoubt G, (*Pl.* 4. *Fig.* 21.) this work, together with the two coupures

w' and *x'* which the besieged troops construct during the siege, unless permanent ones were previously made, form the retrenchment of the ravelin; so that it only remains to cover, by means of a tambour, the communication at the gorge of the redoubt.

But if a full ravelin should happen to contain no permanent redoubt, a temporary one, consisting of earth, is to be constructed, besides a coupure on each side; the extent of this redoubt should be regulated according to the interior space of the ravelin, and its profile arranged conformably to the directions just given (176) respecting that of the retrenchments of bastions; only, the command of the redoubt over the ravelin is generally made equal to half the command of the body of the place over this work.

With respect to an empty ravelin, nothing can be usefully done to retrench it, except constructing a tambour which covers the communication at the gorge, and thus facilitates the retreat of the troops who have defended the ravelin.

178.—The smallness of the saliant places of arms not allowing any works of earth to be constructed within them, tambours are simply made which answer the same purposes as the tambours placed in the empty ravelins, &c.

179.—A re-entering place of arms which contains a permanent redoubt, requires no other retrenchment; with the exception however of a

tambour, to cover the communication at the gorge of the redoubt. But supposing that a re-entering place of arms has no permanent redoubt, whilst its dimensions and every other circumstance allow one of earth to be constructed within it during the siege, this redoubt ought to be made. In short, if a re-entering place of arms, destitute of a permanent redoubt, should also happen to be so small as not to admit of one of earth, or, if the besieged troops had not the necessary means to construct the latter, their only resource is to erect a tambour; or else, a work composed of strong palisades planted close to each other, with a banquette behind them, the sort of parapet which they form being thickened above the banquette by means of turf, or of clay intermixed with chopped straw.

180.—A tambour consists of pieces of oak *a* (*Pl.* 7. *Fig.* 43 *and* 44.) 12 feet long, and from 6 to 7 or 8 in. thick, which are vertically fixed in the ground, close to each other, so as to be left about 7 feet high. It is secured in front by a ditch *b*, besides fraises *c* in the escarp; and loop-holes *d* are made in the tambour, at every 2 feet of its length, passages being left at its extremities, near the counterscarp of the ditch behind, with gates to shut them up when circumstances require it. The tambour of a saliant place of arms usually follows the direction of the

circular part of the counterscarp in question, and is terminated by two small flanks, one at each end, in which the passages are made; whilst that of a re-entering place of arms has the form of a redan; but in whichever situation the tambour may be placed, a sort of shed *e* 6 feet wide, consisting of planks 2 inches thick, is fixed on its top, and supported at every 6 feet by pieces of timber *f* fastened to it. The object of this shed is to secure the troops in the tambour from the besieger's grenades, and, as it slopes inwardly, it follows that in the saliant places of arms the grenades falling upon it roll down into the ditch of the ravelin or the bastion behind; but, in the re-entering places of arms, a small ditch should be made behind the tambour, for the purpose of receiving the grenades, the nearest side of this ditch to the tambour being placed exactly under the interior edge of the shed.

181.—The traverses *a (Pl. 7. Fig. 51.)* which the besieged troops construct upon the terrepleins, in order to render them less liable to enfilade, usually consist of gabions 4 feet 6 inches long and 3 feet in diameter, which are placed in 4 rows close to one another, with 3 other rows over them. All the gabions are filled with sandbags, and connected together by means of fascines, &c., so that the traverses may be firmer.*

* Traverses have sometimes been made with wool-bags, so

The object of the Parados is to secure the besieged troops from any reverse fire to which they may be exposed. The method of constructing them is the same as that used for traverses.

182.—The blindages made in a besieged town may be variously disposed according to the particular use of the bomb-proof that they are intended to form. Cormontaingne suggested the following method of constructing those which have for their object to secure buildings inwardly, and which, similarly to any other blindage having a horizontal roof, are called *horizontal blindages*, or *timber bomb-proofs*.

Conformably to this method, and the interior breadth of the building not exceeding 21 feet, uprights *a* (*Pl.* 8. *Fig.* 52.) are placed in a row within the building, in the direction of its length, with their lower end firmly fixed in a sill *b*, and the distance from the centre of each upright to that of the next being 11 or 12 feet. The uprights are connected together by means of beams *c* horizontally laid on their tops, and which the cleats *d* retain in their position; these beams, and consequently the uprights, support girders *e* which extend across the building and have their extremities fixed in the walls;* beams *f* are placed close to one

that being composed of lighter materials, they might be more conveniently removed from one place to another; but this method is very uncommonly used.

* Cormontaingne recommends that the uprights, girders,

another upon the girders, in the direction of the length of the Building,* so as to support the beams *g*, which, similarly to the former, are close to each other, but have a contrary direction; two rows *h* and *i* of logs of wood arranged as the Fig. shows, are laid over the beams *g*, and the places where the extremities of the logs in the row *i* meet, are covered by other logs *k*. The upper part *l* of the blindage consists of about 3 feet thick of dung; or, when the strength of the walls allows it, of 5 or 6 feet of earth.

The doors and windows of the building are secured by means of beams *m* which are for this purpose obliquely fixed opposite them, against the exterior faces of the walls; and for greater precaution, fascines and earth, with turf over them, are laid against these beams, to a thickness of 3 or 4 feet. (See Fig. 55 and 56.)

183.—As an improvement of Cormontaingne's method of making the abovesaid horizontal blindages, another process was of late years suggest-

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and other beams used for a blindage of this nature, should be 1 foot square; and also, that the girders and the beams over them should be proped at every 10 or 11 feet; therefore, any building wider than 21 feet between the walls, will require several rows of uprights. The diameter of the logs of wood is to be from 6 to 8 inches, or thereabouts.

ed. According to this process, the uprights *a* and the girders *b* (Fig. 53.) only are 12 inches wide and 8 inches thick, the breadth of the beams *c* and *d* being 12 inches, and their thickness 4 inches; but these beams, as well as the girders, are to be laid on their narrower face, with an interval of 4 inches between each two beams; and short pieces either of planks or joists should be from distance to distance tightly fixed in this interval, their number depending upon the nature of the wood of which the beams are made, and its smaller or greater elasticity. At each end of the girders, inside of the building, an upright *e* 8 inches wide and 6 inches thick is placed close to the wall, and those parts of the walls against which the dung or earth is laid are lined with strong planks *f*. The remainder of the work, within the building, is to be executed conformably to Cormontaingne's method, but, for greater security, the exterior faces of the walls should be supported, opposite the extremities of each girder, by two props *g* and *h* 12 inches wide and 8 inches thick, which are fixed together by means

* The width of the props *g* and *h* may be reduced to 8 inches, and their thickness to 6 inches, without materially impairing the strength of the blindage. Trunks of trees with the bark on, and which have suitable dimensions, may also be used for these props, instead of squared timber.

of two joists *i* and *k* 4 inches square;* these props of course require different lengths, the prop *h* being intended to support the upper part of the wall, whilst the prop *g* is to strengthen the lower part; both props have their lower extremities fixed in a piece of timber *l* placed in a horizontal direction, and which also retains in its situation the foot of another piece *m* standing vertically against the wall; the upper ends of the props are kept steady by means of cleats *n* fastened to this piece.

The above new process has the material advantage of requiring much less timber than Cormontaingne's method; and, as the smaller dimensions of the various pieces of timber used render them lighter, the work can be executed with greater convenience and expedition; but neither one nor the other method admits of the thickness of the walls being under 2 feet 8 inches, or thereabouts.

184.—Such buildings should be selected, for the purpose of securing them by means of horizontal blindages, as extend lengthwise in the presumed direction of the enemy's fire, and have their walls concealed from his view. Buildings of this kind having only one story are still to be preferred to those of a greater height, as the operation of securing them will be more simple, and will require less time and expence; and if the height of the story is such that it may

be conveniently divided by a kind of loft, advantage should be taken of this circumstance, which will afford the means of having double the room, with but a trifling additional expence.

If the garrison should however be obliged to secure a building which is more than one story high, the blindage is in this case to be placed on the upper floor, as such a disposition will allow a much larger portion of the building to be secured, without the requisite quantity of timber being on that account proportionally increased, or the carpentry and walls much more affected by the weight of the blindage, than if it had been placed lower; besides, the necessary number of secured buildings will be smaller. With respect to the method of constructing the blindage, the uprights *a* and *e* on the ground-floor (Fig. 53.) should at first be fixed, and the girders *b* laid upon them; after which, other uprights and girders are to be placed precisely over the former, so as to correspond exactly with them. The blindage is then to be completed according to the process explained. (183.)

185.—Whenever a horizontal blindage is placed on the upper-floor of a building several stories high, and the building happens to be much exposed to the fire of mortars, or situated within a fortification of a small extent, such as a fort, &c. the stacks of chimneys are to be taken down

to the level of the floor upon which the blindage is constructed;* and stoves, with their pipes passing through the windows, should be established in those parts of the building which are inhabited by troops; or else, the stacks of chimneys may according to circumstances be demolished for only such a height as will allow the remaining portion to be secured by means of blindages made within the loft of the building, and so disposed as to leave issues for the smoke from the chimneys; so that it may afterwards pass through the sky-lights, or other apertures in the roof.

Strong pieces of timber may also be vertically and tightly fixed in the windows of the upper-stories, each piece being 3 or 4 inches distant from the next.

186.—The roof of any building which contains a horizontal blindage should be preserved, as, if it were demolished, the dampness occasioned by the rain-water would injure the building, and render it unhealthy for troops; besides spoiling many of the articles of subsistence and ammunition that might happen to be placed there. But if, on account of the roof being suffered to remain, any accident by fire should be apprehended, the body of firemen which it is necessary to establish in every besieged town, and to distribute in the most exposed quarters, should be ordered to observe very carefully such build-

ings in particular as are secured by means of blindages.

187.—The lamentable scarcity of permanent bomb-proofs, in the fortresses hitherto constructed, rendering temporary ones highly useful; and particularly in small fortresses, it is undoubtedly requisite that the methods of making these bomb-proofs should be explained in any work intended to elucidate the operations relating to the defence of places; but it should be observed that walls have not commonly such a thickness as would enable them to support horizontal blindages; whilst the considerable quantity of timber of large dimensions which these blindages require may be inconvenient in procuring; their use is therefore necessarily limited, notwithstanding their great utility.

188.—Independently of the horizontal blindages just spoken of, others may be constructed which are called *inclined blindages,* or *splinter proofs.* They consist of pieces of timber *a* (Fig. 54, 55, 56, 57.) placed close to each other, in an inclined direction, against walls either vertical or sloping. The smallest diameter which these pieces of timber should have, not including the bark, is from 12 to 15 inches when their situation does not render them liable to the direct percussion of the shells, but 18 inches under different circumstances; they only require to be squared on two

opposite sides, so that one piece may fit the next, and their lower end *b* is to be sunk into the ground to a sufficient depth to make them steady; whilst the upper end *c* should be cut slanting, in order to apply it exactly to the wall. The blindage is then strengthened by means of fascines *d* (Fig. 55, 56.) laid close to the exterior surface of the pieces of timber, these fascines and the chinks between the pieces in question being covered with clay and chopped straw mixed together, upon which turf *e* may also be placed. In respect to the length and inclination of the pieces of timber, they should be such that the distance from their lower end *b* to the wall being 6 feet at least, the height of the blindage may be neither less than $1\frac{1}{2}$ that distance, nor more than double.

Besides other purposes, inclined blindages serve to cover the doors of powder-magazines, the entrance from the ditch into a postern, or to form places of security for troops; and particularly along the front of attack, and the collateral fronts, as the troops stationed under the blindages being at a short distance from the attacks, can rapidly advance to any spot where they may be required. Dry ditches afford a convenient situation for blindages of this kind, on account of the facility which they give of fixing the timber against the revetments; but it is still preferable to construct the blindages along such

walls as may happen to support inwardly portions of the rampart. In short any walls properly situated, and which are sufficiently strong to support the blindages, may be employed for this purpose.

It is to be observed that inclined blindages should generally face towards that side where they will be the most secure from the enemy's direct fire.

An inclined blindage may also be advantageously made against the exterior walls of a building interiorly secured by a horizontal blindage, as besides its utility in other respects, it will afford a safe communication round the building; as well as the means of establishing under cover of the blindage temporary fire-places similar to those which the French call *cuisines de campagne.* Passages about 2 feet 6 inches wide should be left from distance to distance between the pieces of timber which form the blindage, being placed opposite such parts of the walls as do not contain either a door, or a window.

189.—Fig. 58, 59, 60, show the construction of another kind of blindages; these are called *double blindages,* and have two opposite faces, either upright or slanting, besides two vertical gable-ends. The timber for the faces requires 18 inches diameter at least, and the gable-ends are made with joists 3 or 4 inches thick, being se-

cured on the outside by means of an inclined blindage *a* (Fig. 59.) when their situation renders them liable to the direct fire of the besieger. It is proper, when timber sufficiently long for this purpose can be procured, to give such height to the blindages as will allow a loft *b* to be constructed within them, provided however that this height will not improperly expose them to any direct fire.

Double blindages are chiefly employed when there is no building in the place which admits of being made secure; or, in order to lodge safely under them part of the defenders of such detached works as are destitute of permanent bomb-proofs; and if these blindages are to serve at the same time as guard-rooms and redoubts at the gorges of the works where they are situated, both their faces and gable-ends should have loop-holes, with inclined palisades in front for greater security.

190.—Inclined blindages and double blindages may no doubt answer very useful purposes, similarly to the horizontal blindages; but like the latter, they require for their construction a considerable quantity of timber of large dimensions, as well as a long time and a great labour. Besides, the places of security established by their means are not sufficiently extensive and commodious to afford advantages capable of overbalan-

cing in all circumstances the abovesaid inconveniences which the blindages in questiòn have; therefore, they should not be indiscriminately used.

191.—Temporary powder magazines may be formed by means of galleries A lined with timber (Fig. 61, and 62,) which are made in the ramparts; their requisite dimensions of course depend on the quantity of powder or ammunition which they are intended to contain, and security requires that they should be covered with earth to the height of 6 feet at least.

Similar galleries may be constructed for the purpose of securing troops; but, in this case, they should be supplied with air-holes.

192.—If it should be apprehended that any permanent powder magazine, arched over according to the usual construction, is not sufficiently secured, pillars of masonry may be erected close to the exterior face of the walls which form the piers, the distance from each pillar to the next being 6 feet; these pillars are to be carried up to such a height as will allow them to retain in their positions several rows of pieces of timber, with the bark on, which should be placed horizontally over each other, in the direction of the length of the walls, so as to support a proper quantity of earth or dung laid upon them and the crown of the arch.

Supposing that it should not be convenient to

construct pillars of masonry, pieces of timber disposed in the same manner may be substituted for them; observing to augment their stability by means of strong props bearing against them in an inclined direction, and which are firmly fixed at both ends.

193.—Fleches *u* (Pl. 2. Fig. 6.) are small works which the garrison of a besieged town generally constructs at the foot of the glacis,* upon the prolongations of the capitals of the front of attack, so as to keep watch over the besieger, and impede his advance by obliging him to defile the boyaux from the fire of the fleches, and delay the construction of the 3rd parallel until he has taken them. These works consist of two faces, about 30 yards long, which form an angle, and flanks are occasionally allowed to them; their escarp is protected by fraises and their gorge palisaded, the latter containing the entrance, which is secured by a barrier.

In order that fleches may be more speedily constructed, their parapet is usually traced by means of two or three rows of gabions, and afterwards thickened. With respect to the direction of the faces, they are made parallel to the glacis, whenever the localities allow it, so that the fleches

* If there should be any advanced glacis, fleches may also be placed at the foot of this work.

may be effectually flanked by the covert-way behind them, as well as by the bastions and ravelins.

Fleches may also be made behind an advanced ditch, or an advanced covert-way, in order to protect them; but they should in this case be placed at the foot of the glacis in front of the re-entering places of arms, as this situation will enable them to afford a very useful flanking defence upon their right and left, and to be flanked by the covert-way and ravelins from a small distance which allows even a musquetry fire to be effectually kept up for this purpose; whereas, by placing the fleches opposite the bastions and ravelins, those in the latter situation would be feebly protected, and would afford no flanking defence from which any material advantage might be derived.

It is to be observed that whenever fleches are constructed in the rear of an advanced covert-way, the direction of their faces should be such as not to allow the besieger to enfilade them from the crest of the advanced glacis.

194.—In order to enfilade the boyaux, the besieged troops frequently construct upon the flanks of the attacks works called *counter-approaches,* which they place on some advanced spot advantageously situated for this purpose. A counter-approach sometimes only consists of a trench where troops are posted to keep up a musquetry

fire, but it is more commonly intended for artillery; a communication, in the form of a trench, leads from the covert-way to the counter-approach, being defiled from the attacks, and covered by a parapet either on one or both sides, as may be necessary in order to secure it; this communication is called *a line of counter-approach.*

As soon as a counter-approach is no longer useful, the besieged troops destroy it.

195.—The palisades which serve to protect the covert-way, should be vertically planted in one row upon the banquette, 10 or 12 inches distant from the foot of the interior slope of the glacis, and with their points projecting from 12 to 15 inches over the crest of this work; the usual distance from each palisade to the next is 3 inches, and their lower extremity is sunk $2\frac{1}{2}$ or 3 feet into the banquette, the band which secures them at top being placed on the side towards the covert-way, about 2 feet 6 inches below the points. It is proper that a pointed piece of iron should be fixed in the band, between every two palisades, so as to prevent the besieger from stepping upon it, in order to leap down into the covert-way.

It was suggested that independently of the row of palisades just mentioned, another row should be planted behind it, between each two traverses, the palisades in this row being 2 feet distant from

the foot of the slope of the banquette, and their projection above the crest of the glacis equal to that of the palisades in front. According to the same scheme, the palisades in the second row are to meet at one of its ends those placed on the banquette of the contiguous traverse; whilst a passage, secured by a barrier, is to be left at the other end, close to the traverse on that side, for the purpose of establishing a communication between the two portions of the covert-way which the palisades in the 2nd row separate. A banquette is to be made behind these palisades, with steps to mount upon it; and, in order to secure the soldiers from the musquetry-fire of the besieger, fascines are to be vertically fixed in the intervals between each two palisades, so as to form with them a kind of parapet which, for greater security, should be thickened above the banquette by means of turf, or of clay mixed with chopped straw.

The object of this method of palisading the covert-way is to augment the difficulty of storming it, and to facilitate the retreat of the troops who have defended it; but it should be observed that independently of the much greater number of palisades which such a method requires, those in the 2nd row considerably impede the manœuvres of the garrison in the covert-way, and the communication within it; they also augment the quantity

of splinters produced by the enemy's ricochet-fire, and, as they must be planted at an early period of the siege, most of them will be destroyed before the covert-way can be attacked; so that after gaining the crest of the glacis, the besieging troops will be able to direct a plunging fire upon those posted behind the palisades which remain, as well as an enfilading and a reverse fire; whilst the sappers will cut down these palisades in safety, being covered by them from the fire of the place. It follows from the above observations that, besides the inconveniences of the method in question, it does not afford effectual means to keep off the enemy from the covert-way; and also, that after he has penetrated into this work, the 2nd row of palisades will actually be of advantage to him, instead of being useful to the garrison.

CHAPTER VIII.

On the requisite operations of the Garrison, during the 1st period of the Siege.

196.—As soon as it appears from the preparations and movements of the enemy that he will very shortly lay siege to the place,* the garrison should forward, without any intermission, such dispositions requisite to put it in a state of defence, as are not yet completed. The barbet-batteries, together with the cavaliers which the place may happen to have, are to be instantly supplied with heavy artillery, so as to impede the enemy in forming the investiture; whilst arrangements should be made to remove into the interior of the country the women, children, and old men, whocan be of no service during the siege. The cattle, forage, dry vegetables, wine, liquors and other articles of this kind, which may be found in the neighbouring country, are to be brought into the town, and a plan concerted in order to keep up intelligence with that country, either by signals or otherwise, so that the enemy's posts may be

* Whenever a fortress is liable to be very soon besieged, parties should be sent from it every day, for the purpose of observing the enemy.

broken through with greater facility, and such succours introduced into the place as may be sent to the besieged troops.

197.—The garrison should in day time also have posts in advance of the place, for the purpose of keeping off the enemy, and thus obliging him to reconnoitre the fortifications from a greater distance, as well as the ground immediately before them; but care should be taken in establishing these posts, to place them in situations which will allow the troops to retire safely with any artillery that they may have, whenever their retreat is to be effected.*

198.—Besides the aforesaid dispositions, the garrison should be organised suitably for the defence of the place, and particular companies formed, consisting of grenadiers and other soldiers of known bravery, who may be depended upon in those circumstances which are the most dangerous, and require the greatest exertions. Horse-artillery, with light field pieces, are likewise to be appointed for the exterior operations, and all the troops trained to the various manœuvres that they may have to perform during the siege, either in the day or the night; the officers

* In order to keep off the enemy's reconnoitring parties still more effectually, small detachments, concealed from their view, may be stationed in the intervals between the posts.

being made acquainted with the properties of the fortifications, by means of instructions delivered to them previously to the practice of the manœuvres.

199.—The manner in which the troops are to do duty, should also be regulated. According to the usual custom (at least in most services) one third of the troops get rest, whilst another third are actually employed, and the remainder ready to march if it should be requisite; but it is preferable, provided the strength of the garrison allows it, that one half of the troops should rest themselves, whilst one fourth are under arms in presence of the enemy, and the other fourth in a state of readiness.

200.—The investing corps being in sight, the cavalry and horse-artillery of the place should reconnoitre it; they ought to be supported by light and other infantry forming echelons, and who are so posted as to surprise such of the enemy's troops as might inconsiderately advance. Subsequently to this reconnoitring, a kind of petty warfare is to be commenced against the enemy, which will prove very prejudicial to him if the garrison carries it on in a judicious manner, and with great activity. The troops employed on this service should, without improperly exposing themselves, attack the enemy on different points alternately, lead him into snares if possi-

ble, and endeavour to surprise some of his troops in the night, by laying ambushes of which they cannot be aware if the soldiers who occupy the posts established in advance of the place, for the purpose of keeping off the enemy's reconnoitring parties, have done their duty. In short, every means of annoying the enemy should be used in this petty warfare; whilst a fire of artillery should in the mean time be kept up from the place and the posts in its front, upon any of the investing troops who may show themselves at such a distance as allows this fire to be effectual.

201.—After the arrival of the besieging army, the garrison should endeavour to discover which are the fronts intended to be attacked; and also, at what time the besieger will proceed to the opening of the trenches.

Various indications may enable the garrison to discover against which fronts the besieger intends to carry on the attacks; such as the spots where he places his grand park of artillery and his depots of materials, the nature and direction of his communications, and the order in which the besieging army is encamped; inferences in this respect may also be drawn from the disposition of the works belonging to the place, their absolute and relative strength, and from the particular motives which may induce the besieger to attack one front in preference to another, al-

though the former perhaps admits of a stronger defence than the latter. However, the besieged troops are not to judge from the above circumstances only, but must employ every other means which may put it in their power to obtain more precise information; this precaution being so much the more requisite as the besieger may make a show of preparations in several places, for the purpose of deceiving the garrison.

With respect to discovering the time when the besieger will be engaged in opening the trenches, light balls should for this purpose be thrown to the distance of about 600 yards from the place, for several hours in the beginning of every night, as soon as it is presumed that he may be ready for the operation in question. Posts are likewise to be placed in ambush, and patroles sent, as well as trusty single individuals, who are to act with great precaution, and report what they may have seen, or heard.

202.—It is to be observed that after the besieging army has established its camps,* the artillery of the place should be distributed for the particular purpose of impeding the opening of

* If it should happen that the besieging army has inconsiderately placed any of its camps within reach of the garrison's artillery, this camp is to be fired upon, so as to oblige the army to remove it to a greater distance from the place.

the trenches; therefore, independently of the barbet-batteries, the besieged troops should convey all the artillery which they can dispose of to the ramparts and covert-ways of the fronts liable to be attacked. The light pieces (including howitzers and mortars mounted upon gun carriages*) are to occupy the covert-ways, being placed at a proper distance behind the glacis, so as to afford a ricochet fire over its crest. Such of the pieces brought to the ramparts as are intended to keep up a ricochet fire, should of course be also established at a suitable distance behind the parapet, so that the shot or the shells may pass over it.

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* For the sake of brevity, the expression *gun carriages* will henceforth be used to denote such carriages as allow the mortars mounted upon them to be fired in a horizontal direction.

CHAPTER IX.

On the requisite Operations of the Garrison during the 2nd Period of the Siege.

203.—The besieged troops having ascertained that the enemy is manœuvring or at work on some particular spot not far distant from the place, a direct and a ricochet fire should instantly be directed upon that spot from the whole of the artillery conveniently situated for this purpose. This fire is to be briskly continued until patroles, with engineers at their heads, and supported by proper detachments, advance as near the enemy as possible in order to reconnoitre whether he actually is opening the trenches, or about any other operation.

204.—If the engineers should report that the enemy is breaking ground, light-balls are to be thrown in every direction where they may allow his trenches to be seen, so as to open a direct and a ricochet-fire upon them and the troops who cover the workmen, from the artillery of all the fronts suitably placed.* This artillery is

* By observing the disposition of the enemy's trenches, and particularly their length, the besieged troops will also

to be immediately re-enforced by means of pieces brought from the other fronts and the reserve.

Besides, light guns and howitzers, with infantry and cavalry to support them, should take an advanced position towards the extremities of the enemy's trenches, so that their fire may bear in flank upon the covering troops, as well as in an oblique direction,* and also answer the purpose of throwing the workmen into confusion.

A sally is likewise to be made, with two thirds of the garrison, about two hours after the artillery has opened its fire. The principal object of this sally, and indeed, of the manœuvre in general, is to induce the workmen to disperse, by creating alarm among them; and, in order to execute it, the cavalry and horse-artillery, supported by the light infantry, are to advance towards the ends of the trenches, from the collateral parts of the fortifications, so as to oppose the cavalry of the besieger; at the same moment the other infantry, with light artillery upon its flanks, is to attack the covering troops in front; this infantry, as

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be able better to judge whether he actually is commencing his operations, or only carrying on a feigned attack, in order to draw their attention to the spot where he is at work, and then really break ground with greater safety on another spot.

* The oblique direction of the fire above alluded to is what the French call *en echarpe*.

well as the artillery attached to it, should make several discharges, the artillery being loaded with grape-shot; but they ought not to advance inconsiderately, and must retire before they are attacked by the troops who will undoubtedly be sent to re-enforce the covering party.

The artillery of the place and the advanced batteries towards the extremities of the besieger's trenches should of course discontinue their fire during the time of the sally, but are to recommence it with as much activity as before, instantly after the troops have retreated.

205.—The 1st parallel being completed, the immediate object of the besieged troops must be to impede the besieger in constructing his 1st batteries and the boyaux pushed out from the 1st parallel; for this purpose, the artillery placed in the barbet-batteries of the front of attack and the adjacent fronts, or on traversing platforms if any should be used, is to keep up a lively direct fire on the besieger's batteries and the heads of the boyaux; the large mortars are to occupy the curtains of the same fronts, and to be fired alternately in different directions; whilst the ricochet fire of the pieces established in the covert-way, and which should chiefly consist of howitzers, as well as of mortars, mounted upon gun-carriages, is to be so distributed that part of it will cross over the prolongations of the capitals,

and the remainder follow the direction of those prolongations.*

206.—Previous to the siege, the garrison should be provided with a correct plan representing the whole fortress, as well as the surrounding country, and where the principal works are distinguished by particular names and numbers. This plan is called the *general directing plan of the defence*, and the prolongations of the faces and capitals of the works belonging to the front of attack, &c. are to be drawn upon it, subsequently to the opening of the trenches. The engineers should every morning also mark on the same plan the work of the besieger during the preceding night.

But independently of the general plan in question, a particular plan upon a larger scale is to be made, representing no other part of the fortifications except the front of attack, and those works collateral to it, the situation of which allows their fire to bear upon the approaches. The prolongations of the faces and capitals should be very accurately described in this plan, with the position and extent of the 1st parallel; besides

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* The besieged troops ought not to direct an equal portion of the fire of their artillery upon each of the spots where the besieger is constructing his batteries, but should concentrate a larger quantity of it alternately upon one or two batteries, so as to augment the effect.

every other work which the besieger may afterwards construct, the first disposition and successive changes of the garrison's batteries, the temporary works intended to be made for the purpose of improving the defence, and all other material details of the siege.

207.—Such arrangements previously commenced as may still remain in an unfinished state, should also be completed as soon as the trenches are opened. The powder, ammunition, loaded shells, provisions and other important supplies, which the garrison cannot otherwise secure, are to be removed to the spots least exposed to the besieger's fire, being distributed into several quarters. The small magazines for the ammunition used in the course of each day should likewise be established along the fronts opposite the attacks, as well as places of security for the troops on guard there, and the supplementary troops that these fronts may require in various circumstances; whilst the quarters most suitable for the other troops should be assigned to them, and the order precisely regulated in which duty is to be done, either in presence of the enemy, or with respect to any work which the garrison may have to perform. In short, the fleches and counter-approaches ought to be constructed, together with the requisite retrenchments, coupures, caponiers, bridges, &c.

208.—Besides the aforesaid preparations which the besieged troops ate to make immediately after the opening of the trenches, they should at the same time also construct such embrasures, traverses and parados, as will be requisite for the greater security of their artillery when in consequence of the besieger's batteries being ready for action, it will become necessary to remove the largest portion of it to those parts of the fortifications which are the least exposed, and from whence its fire can effectually bear upon the attacks.*

209.—Whatever precautions the besieged troops may use, for the purpose of securing their artillery, part of it will be silenced before the 2nd parallel is commenced; therefore, they should replace as many pieces as possible, in order to impede the besieger in constructing this parallel and any new batteries which he may have occasion to make in or near it. Those parts of the collateral fronts which their situation has secured from the effect of the besieger's 1st batteries, and from whence the attacks are properly seen, should particularly be supplied with such a

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* If it should be wished to employ any guns mounted on traversing platforms, embrasmes may be made for them by means of raising the merlons with sand-bags placed upon the top of the parapet.

number of pieces as will allow them to keep up a lively fire with direct as well as ricochet shot.

210.—The manœuvres which the garrison should execute, in order to retard the construction of the 2nd parallel, are similar to those explained (204.) with respect to the 1st; but they will be performed under more favorable circumstances, as the proximity of the 2nd parallel to the place not allowing the workmen to be covered but by a small number of troops, who also are much exposed to the musquetry fire of the covert-way, it is next to a certainty that a strong sally properly led will very soon drive back those troops, and disperse the workmen. The sally is then to form in order of battle between the parallel and the enemy, so as to oppose any re-enforcements that might be sent against it, and give time to those workmen of the garrison who follow the sally, with engineers at their head, to destroy that portion of the parallel which is constructed, including the redoubts at the extremities.

211.—It should likewise be observed that within the distance from the 2nd parallel to the place, it is in the power of the besieged troops to make such an advantageous use of their musquetry fire, as will to some degree compensate for the loss of that portion of their artillery which the besieger's batteries have rendered unserviceable; for this

purpose expert marksmen, supported by the fire of the covert-way, should advance upon the flanks of the attacks, in order to enfilade the boyaux, &c. and also annoy the troops in the trenches by their oblique fire; whilst parties of light infantry, should lie in ambush in the night, who are to fire upon the workmen engaged in executing any flying-sap, and to attack them unexpectedly, so as to disperse them; besides, marksmen stationed in the saliants of the covert-way, and supplied with rampart-fusils, should constantly keep up a well directed fire on the heads of all the saps, the proper direction of this fire being marked during the day by means of iron forks fixed in the glacis so that it may be preserved in the night. Indeed, by suitably employing their musquetry, the besieged troops will not only impede the besieger in his advance beyond the 2nd parallel, but perhaps oblige him to use the single-sap for tracing this parallel, although the flying-sap is generally employed.

It is to be remarked that the effectual defence of a fortress does not so much depend on the number of pieces of ordnance that the besieged troops may have in their power to employ, as upon the judicious arrangement and use of the artillery, and the care which is taken not to expose it inconsiderately. The same argument holds good in respect to the musquetry, as the

besieger soon despises even a heavy fire without effect; whereas, on the contrary, a smaller quantity of fire will induce him to advance with greater precaution, if the fire is judiciously distributed and properly kept up.

218.—Sallies consisting of a small number of troops should very frequently attack the besieger whilst he is advancing beyond the 2nd parallel, and particularly after he has gained the spots where the demi-parallels are to be constructed. The only object of these sallies is to alarm and disperse the workmen, but as soon as it is presumed that their frequency must have led the besieger to relax in his precautions against more serious operations, a strong sally is to be made, in order to destroy his trenches, carry away some of his pieces of artillery and spike the rest, &c.

CHAPTER X.

On the requisite operations of the Besieged Troops during the 3rd Period of the Siege.

213.—At this important period of the siege, the defence of the place should be carried on with redoubled energy; the besieged troops availing themselves of the material advantages afforded to them by the disposition of the fortifications and their small distance from the approaches, in order to defend inch by inch the ground through which the besieger is to advance, and render the construction of his works on that ground more dangerous and more difficult for him.

214.—The garrison should make every possible effort to retard the tracing and constructing of the 3rd parallel. If the besieger should venture to trace it by means of the flying-sap, any small sally will disperse his workmen, as, on account of the short distance from this parallel to the place, no troops can be safely stationed in front of the workmen, for the purpose of covering them; but it is probable that the besieger will employ the single sap, and as soon as the sappers have set to work, the fire of pieces of ordnance chiefly placed in the collateral parts of the fortifications, and the positions of which were

previously concealed from the besieger's knowledge, should be directed upon the heads of all the saps (66.); whilst howitzers, established in the collateral ravelins and the saliant places of arms, are to bear obliquely upon the parallel, Most of the artillery brought into action should be loaded with grape-shot, expert marksmen being posted in the covert-way, to keep up an uninterrupted fire upon the heads of the saps. Light-balls are of course to be thrown, so as to see the enemy at work.

215.—The besieged troops having ascertained that, notwithstanding the above dispositions, the besieger has succeeded in carrying on the saps for some length, a strong sally should be made in order to destroy all the work which he has executed. For this purpose, infantry and cavalry are to advance from those parts of the fortifications which are collateral to the extremities of the 3rd parallel, so as to take such a position as will enable them to protect the flanks of the sally. Picked troops should at the same time repair from the covert-way opposite the parallel, to every portion of the latter where the besieger is at work, and stand firm at the ends of each portion whilst the workmen who accompany them are speedily throwing down the gabions and the parapet; but they all should retire as soon as the besieger's troops advance from the demi-parallels, &c. in order to repel the sally.

Independently of this strong sally, small ones should be repeatedly made, which will generally prove sufficient to disperse the sappers. Feigned sallies may also be occasionally executed for the mere purpose of alluring the besieger out of his trenches, so as to direct upon him from the place a destructive fire which was previously prepared.

216.—The fire of the besieger will probably be slackened for a couple of days, after he has completed the 3rd parallel, as relying no longer upon the effect of his batteries behind it, he will be engaged in constructing new ones. The garrison should therefore avail themselves of this circumstance, to re-place at all points as many pieces of ordnance as possible, and convey to the re-entering places of arms mortars which are to be loaded with grenades, &c. A very brisk fire is to be continually kept up, that of the howitzers and mortars being principally directed on the spots where the besieger is constructing batteries.

The parapets, palisades, tambours, and such other defensive means as may require repairing, should also be put in good order, and the retrenchments completed, as well as the coupures; whilst casemates of timber for the artillery are to be made in the saliants of the collateral works, unless they were previously constructed. The fire of these batteries, if properly kept up, will have a very great effect upon the 3rd parallel and the approaches beyond it.

217.—If the garrison should have any reasons to suspect that the besieger intends storming the covert-way,* picked troops ought to be stationed in the re-entering places of arms, besides reserves in the ditches; grenadiers should also be distributed in the latter, for the particular purpose of throwing a great number of grenades into the covert-way, after the defenders have retreated from it. The parapet of this work, as well as those of the works behind it, are to be lined with soldiers, and detachments of grenadiers should be posted in the collateral parts of the covert-way.

Besides the abovesaid defensive dispositions, the artillery should be loaded with grape-shot in all the batteries the situations of which allow their fire to bear upon the covert-way, and those portions of the 3rd parallel to be seen, from whence the storming party is to advance. Light-balls are likewise to be thrown for the whole night.

218.—As soon as the storming troops advance from the parallel towards the covert-way, a brisk fire of artillery and musquetry is to be opened upon them from all the works; but after they have gained the crest of the glacis, those troops of the garrison who occupy the saliant places of

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* Inferences in this respect may be drawn from the besieger constructing steps (67.) in the parallel, and placing stone-mortars within it, &c.

arms and the branches of the covert-way, should make a discharge and then immediately retire, some of them into the re-entering places of arms, and the others through the tambours of the salient places of arms; unless the covert-way happening to have a second row of palisades, (195) these troops endeavour to make a short stand behind the palisades in this row, so as to continue firing. After they have retreated, the fire of the place is to be directed against the besieger's workmen and such of his troops as have entered the covert-way; a profuse quantity of grenades should also be thrown upon them, and, as soon as any confusion among them is perceived, the troops in the re-entering places of arms are to charge those of the besieger in the covert-way; whilst the grenadiers posted in the collateral parts of this work rapidly advance upon the glacis, in order to turn the lodgment which the besieger has commenced for the purpose of crowning the covert-way, and thus enable the workmen who follow them to destroy that lodgment.

219.—If instead of storming the covert-way the besieger should gradually advance towards it, as many howitzers and mortars as the besieged troops can bring into action should continually fire upon his approaches and batteries. Stone mortars are also to be conveyed to the saliant places of arms, and expert marksmen posted for-

the purpose of keeping up an uninterupted fire with rampart-fusils against the heads of the saps; whilst sallies, sometimes small and at other times consisting of a greater number of troops, should repeatedly attack the sappers in the night. Oblique embrasures are likewise to be pierced through the parapets of the curtains of the front of attack and contiguous fronts, as well as through that of the ravelin on each side of the former front; so that being ready when the besieger commences the cavaliers of trenches, the fire kept up through them may impede the construction of these works.

220.—Although the troops posted in the saliant places of arms will not be able to remain there after the besieger has erected the cavaliers of trenches, yet some of the soldiers should endeavour to return occasionally to these works in the night, by keeping close to the palisades, so as to throwas many grenades as possible into the saps that the besieger is pushing on in order to gain the crest of the glacis and then crown the covert-way. The requisite disposition of the artillery of the place, for the purpose of impeding this operation, is such as follows:

221.—Batteries with oblique embrasures should be made upon the curtain of the front of attack and those of the adjacent fronts, so that their fire may be directed against the besieger's lodgments before the bastions; whilst other bat-

teries, with oblique embrasures also, and secured if possible in casemates of timber, are to be formed in the collateral ravelins and their redoubts, so as to direct their fire upon every part of the crowning which they see to advantage. The flanks of the bastions of the front of attack should likewise contain batteries, intended for the same purpose as those along the curtains, and which may be inclosed in casemates of timber when circumstances allow it.* Besides, the garrison should endeavour to construct casemates of this kind in the flanked angles of the bastions, so that a fire may be kept up by the artillery placed there, upon the lodgment of the besieger in front of the central ravelin.

The above mentioned disposition of the artillery allowing it to see the spots where, after crowning the saliants of the covert-way, the besieger is to establish his counter batteries and breaching batteries, an uninterrupted fire should be directed upon those spots, whilst the besieger is engaged in constructing the counter batteries and breaching batteries in question.

* It is proper that the flanks of the bastions collateral to the front of attack should also be supplied with artillery, so as to direct its fire upon the besieger's lodgments opposite the bastions of this front; but no casemates of timber are requisite to secure the artillery of these flanks.

222.—The besieged troops being obliged to retire from the covert-way, with the exception of those in the re-entering places of arms, the traverses should be destroyed one after another, either with cannon or by means of fougasses previously prepared, so that they may not afford any cover to the besieger in executing the descents into the ditches, and constructing batteries on the terreplein of the covert-way. The traverses of the re-entering places of arms are of course to be excepted.

As soon as it is perceived that the enemy is commencing any descent, shot made of combustibles should be thrown upon the spot where he is at work, as well as shells from mortars and howitzers.

223.—The kind of defence which may be afforded to ditches depends on their nature. Supposing a ditch to be filled with stagnant water, the only means that the garrison has of defending it consist, first, in directing upon the opening through the counterscarp, the fire of a battery so situated as to see that opening, this battery being covered, if possible ; and secondly, in keeping up a fire of artillery and musquetry upon the besieger's works across the ditch, from the flank which protects it.

224.—The besieged troops may on the contra-

ry employ for the defence of a dry ditch, not only the fire of their artillery and musquetry, but also sallies. Supposing for instance that the ditch to be defended is the principal ditch; independently of the fire kept up from the place, troops assembled behind the tenaille of the front of attack, or in the ditches of the collateral fronts, may from thence sally upon the besieger whilst he is engaged in constructing the epaulment for the passage of the ditch. Such sallies as in this case have only for their object to disturb the enemy's sappers, so as to delay the progress of their work, should consist of a small number of men, and be very frequently repeated; but if any favourable opportunity should offer itself of destroying the epaulment and carrying away the sappers, &c. a strong sally ought to be immediately made.

225.—Those ditches which by means of sluices the garrison may at pleasure keep dry, or fill with water, admit of being defended more effectually than any others; and particularly when the sluices are so disposed as to allow a considerable quantity of water to be let in and out several times, in a rapid current; for, besides the difficulty which the besieger has in constructing the works suitable for passing a

ditch of this description, and the danger of their being set on fire by the besieged troops, these troops may at first keep the ditch dry, in order to avail themselves of all the means which the nature of such a ditch affords to defend it: after which, the sluices may be opened when the besieger is nearly arrived at the foot of the breach, so that the water rushing with great force against his works, and passing over them in a large body, may carry them away, together with the rubbish from the breach; and, if this manœuvre should happen not to succeed the first time, it may be repeated until it has at least produced the effect of rendering the breach unsuitable for the assault, by clearing away the rubbish.

226.—The requisite preparations for the defence of any breach consist in covering it with crows-feet, and collecting a great quantity of combustible matters at its foot, such as tarred fascines, &c. in order to set fire to them on the approach of the storming troops, besides throwing grenades and rolling down loaded shells upon these troops. Mines placed under the breach, and which are to be fired as soon as the storming party gains its top, will also prove very beneficial to the defence.

227.—With respect to the dispositions to be

made at the time of the assault, the nature of them depends upon whether the work intended to be stormed is or is not retrenched. Supposing that it has no retrenchment, troops supplied with musquets and grenades should occupy the top of the breach as soon as the enemy gains the ditch, so as to keep him off for the longest possible time; being supported by other troops composed of strong men wearing cuirasses, who are to be formed in close order, and armed with pikes and other long weapons. Upon the appearance of the enemy on the top of the breach, the troops posted there should immediately retire sideways, in order to make way for the others who then should attack the enemy with impetuosity, for the purpose of driving him back into the ditch. This manœuvre is to be repeated with fresh troops, as many times as the enemy renews the assault.

228.—But when the assaulted work is retrenched, grenadiers and other troops should be posted on each side of the breach, and facing it; they only are to resist the first efforts of the storming party, and should speedily retire within the retrenchment, after making a close discharge, as soon as the enemy has forced his way to the top of the breach; the whole fire of the

retrenchment, including that of some pieces of light artillery loaded with grape-shot, is then to be directed upon the enemy's troops and such workmen as are engaged in constructing a lodgment under their protection;* and if any confusion amongst them should be observed, troops must immediately sally upon their flanks from the retrenchment, and charge them with the bayonet, &c., without firing. In case of this manœuvre obliging the enemy to retire, his lodgment should be instantly destroyed, and such preparations recommenced against a new assault, (226) as were previously made.

229.—In storming a work which is not retrenched, the besieger evidently has this great advantage over the troops who defend it; namely, if he should happen to fail in the first assault, he may retire with security, so as to make dispositions for a second attack; proceeding in the same manner, until he has succeeded; whereas even admitting that the defenders of the work

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* The mines placed under the breach of a work, in order to defend it (226), are more likely to answer that purpose when the work is retrenched, than when it is not. The reason is that, in the former case, the garrison may conveniently set fire to the mines at the proper time; whereas it frequently happens in the latter, that they are fired either too soon, or too late.

might have a temporary success, yet its duration cannot be long; and when obliged to abandon the work, their retreat will be attended with considerable difficulty and danger. But whenever a work is properly retrenched, either by means of a redoubt or otherwise, the troops who defend it may withstand one or several assaults, and thus retard the surrendering of the work, without having any dangerous consequences to apprehend from their procrastinated resistance; as they may afterwards safely retire into the redoubt, or behind such other retrenchment as the work contains, and there oppose the further progress of the enemy.

230.—It follows from the above observations, and from what was previously said on the same subject, that such principal works of any fortress as are liable to be stormed should be retrenched; and particularly those which compose the body of the place; for, without retrenchments, the defeat of the troops who have defended the latter would not only enable the enemy to take immediate possession of the town, but would expose the garrison to dreadful consequences, as well as the inhabitants; so that the garrison would be justified in a great measure in surrendering the place before the assault is given. When on the contrary the works in ques-

tion are properly retrenched, the besieged troops may defend them to the last, and then retire behind the retrenchments, in order to capitulate upon honourable and advantageous terms.